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## A STEREOSCOPIC METHOD FOR THE REMOVAL OF RADIO-OPAQUE FOREIGN BODIES

ESPECIALLY OF INTRA-ORBITAL AND INTRA-OCULAR LOCALISATION

By ERLING RATJEN

The diagnosis of radio-opaque foreign bodies is easy, whereas it may be difficult to determine their position, especially if great accuracy is required, or if information as to their localisation in relation to non-radio-opaque structures is desired. Although, in the course of time, great efforts have been made to refine the technique of localising intra-orbital foreign bodies, it is still so that radiologists and ophthalmologists do not agree on any single method.

During the last 10 years or so, a very accurate technique of radiographic localisation has been developed as an important feature in surgical intervention on subcortical centres. However, even this stereotactic method is only of limited value in the presence of foreign bodies, partly because intra-ocular foreign bodies are embedded in a movable organ, and partly because it is not sufficient to touch the foreign body with an instrument; it must be grasped before it can be removed.

In the Departments of Ophthalmology and Neuroradiology, Aarhus Kommunehospital, we have during the last six months, in collaboration with Johan Thomsen, M.Sc., of Siemens Røntgen A/S, Copenhagen, developed a method which simplifies the treatment of patients with radio-opaque foreign bodies which cannot be removed by a giant magnet or be spotted by the Berman electromagnetic locator.

In two patients, intra-orbital, extra-ocular fragments of the casings of rifle bullets were removed under fluoroscopic control in two planes forming a right angle to each other. An image intensifier with one roentgen tube was used, and the radiologist told the surgeon how the foreign body was situated in relation to the instrument inserted. The experience gained in these two operations

prompted us to elaborate the technique described below.

The most important feature of the method is that the surgical measures can be performed under direct vision, and therefore with greater accuracy and less mutilation than has previously been possible.

We have made the following requirements on a method for the extraction of a foreign body:—

1. The foreign body and the tip of the surgical instrument must be visible to the surgeon at the same time.

2. The relative localisation must appear unquestionably from the visual impression.

3. The space between the organ with the foreign body and the roentgen equipment must allow of manipulation with surgical instruments.

4. It must be possible to remove the foreign body without moving the patient during the operation.

5. The radiation dose to which the surgeon and patient are exposed must be as low as possible.

A few comments on the above-mentioned points 1 and 5 will suffice:—

1. It is seen that the radiologist has been left out in mediating the visual impression to the surgeon. "Remote control" in surgical interventions is at most a second best.

5. The absorptive power of the skull is great. In order to obtain sufficient guidance by ordinary, or reflected, fluoroscopy, a very high kilovoltage and milliamperage must be used for the roentgen tube (Timm 1959), resulting in an excessive dose to the patient. We have therefore used an image intensifier. The brightness of the image is so great that a dim general illumination of the room may be used for the orientation of the surgeon and his assistants. The radiation dose delivered to the areas around the eye was measured while the present roentgen equipment was used. At 85 kV and 3 mAs applied to each roentgen tube, the doses for the right eye were

From the Departments of Ophthalmology (Head: Professor Viggo A. Jensen) and Neuroradiology (Head: E. Ratjen), Kommunehospitalet, University of Aarhus, Denmark.

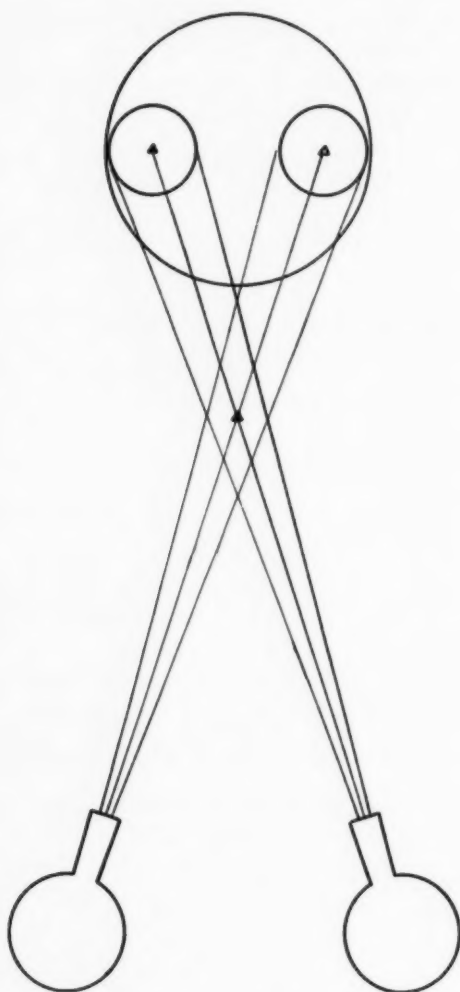


Fig. 1.

*Two narrow beams of roentgen rays converging on a radio-opaque body and the images formed on the photo cathode of the image intensifier.*

determined as about 600 mr/hour in front and to the right of the eyeball, 300 mr/hour just above the parietal region and a little less than 300 mr/hour to the left of the skull. The accompanying diagrams show the principle of the method. Two roentgen tubes placed side by side depict simultaneously the foreign body and the extraction forceps. Either tube emits a narrow beam of radiation illuminating a circular area (diameter 4 cm) on the screen of the image intensifier. This area is of sufficient size for the orientation of the surgeon, as it comprises the entire orbital fossa when the patient is placed in the dorsal position. The two beams of roentgen rays intersect at about 20 cm in front of the screen. The two fields on the screen are separated by a dark,

unirradiated zone, about 4 cm in width (Fig. 1). The kilovoltage and milliamperage applied to one roentgen tube can be chosen independently of the load of the other tube.

Figure 2 shows how simultaneous viewing of the two fields, absolutely unequivocally, reveals the interrelationship between the tip of the instrument and the foreign body.

As already mentioned, the fields on the screen cover the entire orbital area. Figure 3 illustrates how the optimal position of the instrument for the extraction can be determined before a contemplated sclerotomy is performed. The plane through the two central rays (here shown perpendicular to the paper) must be at a right angle to that in which the forceps is introduced (here depicted in the plane of the paper). The two oblique roentgen tubes should therefore be mounted on a turntable (Fig. 4) with a range of motion of 90°. In this way, it is possible to fulfil the above-mentioned geometrical requirement, irrespective of the relative position of the patient and image intensifier.

If it is impossible to introduce the extraction forceps in the plane of the foreign body, the visual impression will be as shown in Figure 5.

If the two fields are adjusted so that the foreign body is exactly in their centres, the accurate distance between the screen of the image intensifier and the foreign body is known. In certain situations, this information will surely be of practical importance (Fig. 6).

The minimum size of a foreign body of which visualisation may be expected was determined by placing a person in front of the image intensifier after having glued tin cubes of various sizes on his eyelids. A cube with a side of 1/3 mm could be visualised. Less intensely absorbing foreign bodies must be larger in order to be recognised.

The accuracy of localisation of a foreign body was first studied on an orange in which a small lead pellet, diameter 1.5 mm, had been embedded. When the orange was placed in front of the image intensifier, three persons who were unfamiliar with the technique were able, in the first attempt following a short instruction, to hit and move the foreign body by means of a lumbar needle.

In the next experiment, two copper foreign bodies were introduced into the eyeball of a rabbit through a sclerotomy; they measured 1.5 × 0.75 mm and 0.75 × 0.75 mm. The larger copper chip was removed with a Thorpe foreign-body forceps in the first attempt (*i.e.*, in less than 10 seconds). The smaller copper fragment floating in the vitreous body could be touched but not removed, because the mass was so small that it escaped together with the surrounding vitreous substance from the branches of the forceps when this was closed. This experiment shows that it is possible to use more slender, and thus less mutilating, instruments than those



Fig. 2.  
Three examples illustrating the various images resulting from different interrelationships between the foreign body and the tip of the instrument.  
Δ, foreign body.  
x, tip of surgical instrument.

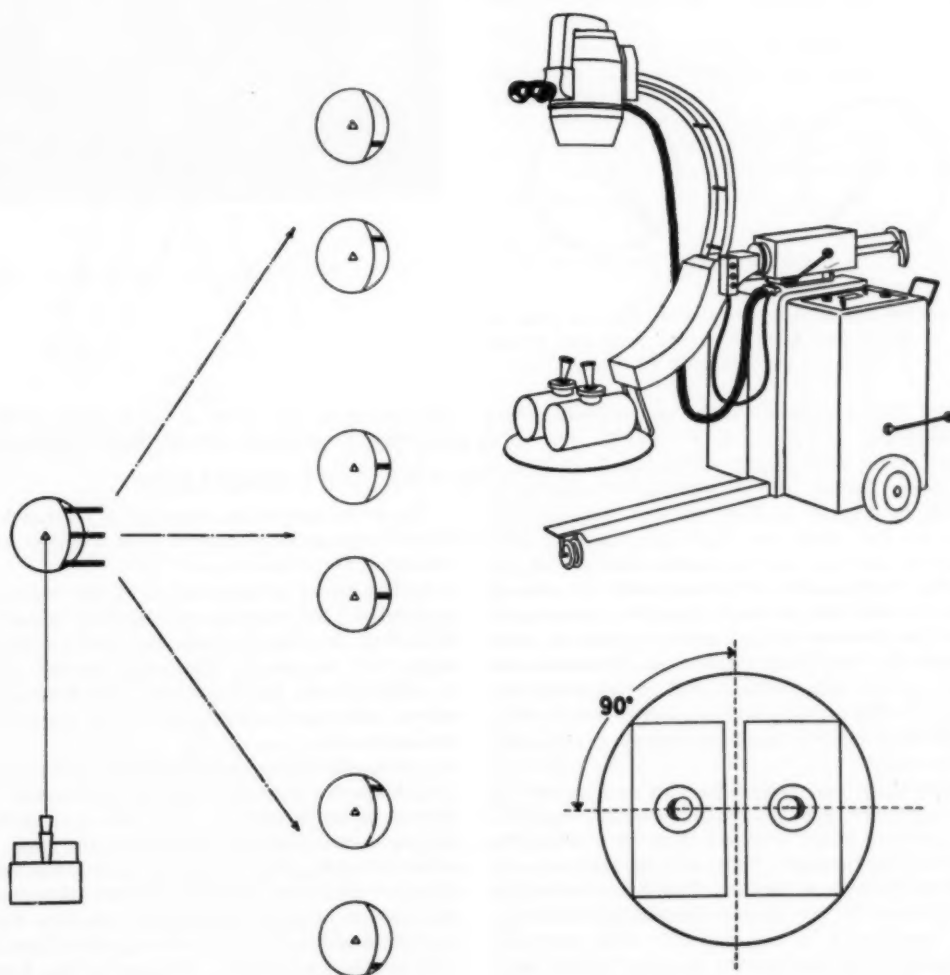


Fig. 3.  
Determination of the correct position of the surgical instrument before it is introduced into the anatomical region.

Fig. 4.  
The mobile and adjustable roentgen equipment with the image intensifier and the two roentgen tubes mounted on a turntable.

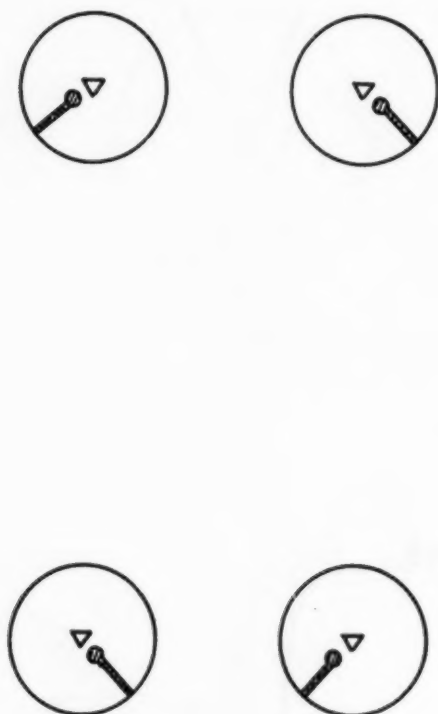


Fig. 5.

*The instrument introduced from a plane in front of that of the foreign body (top) and from one behind that of the foreign body (bottom).*

usually recommended, such as cystoscope-like instruments.

The set-up used in the Department of Neuro-radiology during the experimental studies is shown in Figure 7. The surgeon supports his arms on the table top, and there is sufficient space for his legs and the manipulation with the surgical instruments. The turntable shown in Figure 4 had not yet been mounted on the unit.

So far, the two images are viewed by a small change in the visual direction. However, by means of an arrangement with prisms the two images on the screen may be placed so close together that only a minimal change in the gaze is necessary.

Since then, one patient has been examined by our technique. The diagnostic problem was that of localising some of more than 30 shot in the head of the patient. The very number of shot made it difficult to localise them by conventional radiography in two planes. During the fluoroscopic examination it was possible with certainty to decide that immovable foreign bodies were embedded along the orbital walls, and, what was of major importance, that the presence of intra-ocular foreign bodies could be definitely excluded by requesting the patient to move the eyes.

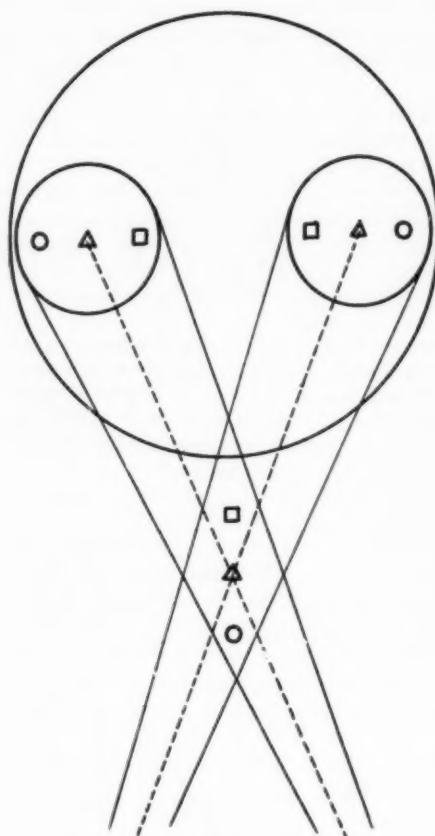


Fig. 6.

*Adjustment of the points of intersection of the two central rays at the site of the foreign body.*

#### CONCLUSIONS

The procedure of the removal of foreign bodies under radiographic control thus consists of the following three phases:—

A. The point of intersection of the two central rays should be adjusted on the foreign body, so that this is visualised in the centres of both images on the screen. The roentgen unit chosen is very mobile; the height of both the roentgen tubes and image intensifier can be adjusted automatically.

B. Supplementary determination of the (extra- or intra-ocular) localisation of the foreign body should be performed by observing its movability during controlled movements of the eye. This determination, in which it can readily be checked that the patient follows the instructions given, is both more rapid and more reliable than that obtained by conventional radiography.

C. Surgical removal. — It appears from Figure 3 how the site of the planned sclerotomy may most appropriately be determined.

The method described does not presuppose any wide experience in radiography for its applica-



Fig. 7.

*The set-up used in the experimental studies.*

tion. It may, without modification, be used for the localisation of foreign bodies in other regions within the skull, bronchi or extremities. It offers the advantage that the foreign body is visible to the very moment at which the forceps removes it from the visual field.

#### SUMMARY

An accurate radiographic method for the removal of radio-opaque foreign bodies is described. On one fluorescent screen, the images produced by two roentgen tubes are viewed simultaneously during the extraction. As the converging beams intersect at the site of the foreign body, the surgeon obtains a very accurate impression of the relative position of the foreign body and the surgical instrument.

During the fluoroscopic examination of the patient, the extra- or intra-ocular localisation of the foreign body can be rapidly and unquestionably determined.

The use of an image intensifier renders the radiation dose delivered to the patient and surgeon negligible.

Preliminary experience gained by this technique is highly satisfactory. It is reliable and easy to perform for an ophthalmologist without special radiographic training.

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## DEVELOPMENT OF CARCINOMA IN THE GASTRIC STUMP FOLLOWING RESECTION FOR ULCER

By LAURA KURZ

During recent years, several communications have been published concerning the increasing incidence of development of carcinoma in the gastric stump following resection for peptic ulceration. Poli reported in 1953 after a follow-up examination 6—14 years after operation of 554 patients submitted to gastric resection on account of peptic ulceration, that 13 or 2.3 per cent had died of carcinoma in the resection stump. K ü h l - m a y e r & R o k i t a n s k y (1954) in an autopsy material comprizing 309 patients who had previously undergone gastric resection found 33 cases of carcinoma of the stomach which corresponds to 10.6 per cent. In these 33 cases operation had been undertaken 10—25 years previously on account of gastric or duodenal ulceration. The carcinoma was most frequently localized to the

fundus of the stomach or, more rarely, to the anastomosis. H e l s i n g s e n & H i l l e s t a d in 1956 published a report of 11 cases of carcinoma found among 222 patients who were submitted to resection during the period 1919—1944. In ten of these cases the carcinoma had developed following gastric ulcer and in one case only following duodenal ulcer. The interval between the gastric resection and the diagnosis of the carcinoma averaged 20 years. When this figure is compared with the incidence of carcinoma in Norway (3.38 per cent in patients with gastric ulceration) the incidence of the development of carcinoma in the stomach following resection for ulceration is thrice as great.

In 1958 K r a u s e in a follow-up examination of 361 patients in whom resection had been undertaken on account of ulceration found that 28 patients had died of carcinoma of the stomach on an average 24.3 years after the resection. In the

From Surgical Department D (Head: Professor E. H u s - f e l d t). Rigshospitalet, University of Copenhagen.



majority of cases, the carcinoma was localized to the site of the anastomosis and in four cases to the cardia.

In these communications the authors maintain that the development of carcinoma is more frequent the older the patients are at the time of resection and the longer the interval since resection. The primary site of the ulcer is not always accurately described, particularly in the materials of Krause and Poli but the majority of the carcinomata appear to have developed following resection for gastric ulceration.

#### MATERIAL

In our department a follow-up examination of 531 patients was undertaken. The material consisted of 473 males and 58 females who had been submitted to operation for duodenal or gastric ulceration during the period 1930—1950 (resection by the Billroth II method).

The site of the ulcer and the average age at the time of the resection appears from Table 1.

Among these 531 patients four cases of carcinoma in the gastric stump were found. These four case histories will be reported.

Table 1.

|                 | Males<br>No. | Average Age | Females<br>No. | Average Age |
|-----------------|--------------|-------------|----------------|-------------|
| Duodenal Ulcer  | 343          | 39 years    | 33             | 40 years    |
| Gastric Ulcer.. | 130          | 43 years    | 25             | 51 years    |
| Total..         | 473          |             | 58             |             |

#### Case 1.

Female aged 50 years who had experienced symptoms of peptic ulceration for 20 years and had been treated with six courses of conservative ulcer treatment with good effect for limited periods. The condition deteriorated during the past two years with periodical occult haemorrhage. Haemoglobin 100 per cent. Ewald's test meal: normal acidity. X-ray examination of the stomach revealed an ulcer niche situated high up on the lesser curvature. The duodenal cap was normal. *Operation:* Ulcer induration was present at the lesser curvature of the stomach and the lesser omentum was also indurated. No macroscopic signs of malignancy were present. The resection was undertaken three cm proximal to the ulcer through healthy tissue. Microscopic examination revealed a simple chronic ulcer with no sign of malignancy. Post-operatively, no complications occurred.

Following the gastric resection, the patient felt completely free from symptoms for 4½ years. Thereafter, uncharacteristic pains under the right rib margin commenced and increased over a period of six months, together with loss of weight and fatigue and the patient was therefore, readmitted. Hb. 70 per cent. Ewald's test meal: free acid. Faeces +++ occult blood. X-ray of the stomach showed that there were no tumour changes in the mucosa of the connected coil of intestine. In the lateral picture, the remaining segment of the stomach was seen to be displaced upwards, and in space between the stomach and spine, a diffuse opacity was observed and interpreted as a soft tissue

tumour. *Operation:* On opening the abdomen, considerable ascitic fluid escaped. The liver was entirely studded with metastases of varying sizes and metastases had occurred by peritoneal spread to the Pouch of Douglas. Close to the site of the anastomosis a nodular tumour was present and had invaded the liver. Biopsy from the liver showed metastases from an anaplastic carcinoma. The patient died five weeks after operation. No autopsy was performed.

#### Case 2.

Male aged 47 years with dyspeptic symptoms suggestive of peptic ulceration for 13 years. The patient had been submitted to operation on three previous occasions for perforated duodenal ulcer and duodenorrhaphy performed. One month prior to the present period of hospitalization, the patient was submitted to operation for a perforated gastric ulcer and gastrophary performed. During the intervals between the operations the patient was fit for work while adhering to an ulcer diet.

Hb. 100 per cent. Ewald's test meal: normal acidity. X-ray examination of the stomach: at the lowest point of the greater curvature a constant hour-glass constriction was present with a narrow passage up towards the lesser curvature. Considerable dilatation of the proximal pouch of the stomach was present with massive fluid content. An ulcer niche was present on the lesser curvature approximately corresponding to the angle of the stomach. No pyloric constriction and no filling of the duodenal cap were observed. *Operation:* the stomach was found to be adherent en masse to the entire inferior surface of the liver and the duodenum was entirely surrounded by adhesions. At the pylorus, a large ulcer tumour was present and, when this was detached from the pancreas, a large ulcer base was found to be present in the substance of the pancreas. Microscopic examinations: simple chronic gastric ulcer with no signs of malignancy. The post-operative course was without complications.

The patient felt perfectly well for two years after the gastric resection. Following a short period in which he experienced a sensation of pressure in the epigastrium, the patient developed haematemesis and melena. The condition responded to blood transfusions. X-ray examination showed good passage through the anastomosis. The mucosal relief in the remaining segment of the stomach was somewhat coarse but no signs of ulcer nor tumour were present. Two months later, transient jaundice developed and, in the course of the subsequent two years, progressive difficulty in swallowing, diarrhoea, loss of weight and anaemia developed.

X-ray examination four years after the resection showed extremely coarse mucosal pattern in the region of the fundus with irregular nodular tumour-like defects and increased distance between the fundus of the stomach and the diaphragm. In addition, the lower end of the oesophagus had become changed into a stiff-walled channel, barely as thick as a pencil, with proximal stasis. Passage through the anastomosis into the intestine was unimpeded and there were no signs of peptic ulceration.

The patient was transferred to the Radium Institute for rotation radiation therapy and died four years and three months after the gastric resection.

No autopsy was undertaken.

*Case 3.*

The patient was a male aged 54 years with a long history of ulcer dyspepsia which had been responsible for a total of six admissions to this department.

During the first two periods of hospitalization 10 and 13 years after the commencement of the dyspepsia, a prepyloric ulcer was demonstrated radiographically on the lesser curvature of the stomach. The duodenal cap was normal. Ewald's test meal showed hyperchlorhydria. The patient was markedly overweight and, for this reason, treatment with diet was instituted with good effect. The third period of hospitalization was six months later on account of marked epigastric pain and melaena. X-ray examination of the stomach showed no sign of either ulcer or tumour but the duodenal cap was deformed and there was niche formation. Ewald's test meal showed hyperchlorhydria. The fourth admission to hospital was two years later on account of acute melaena. X-ray examination showed infiltration in the gastric wall at the lesser curvature of the stomach and with, probably, a little niche. Hb. 75 per cent. Conservative ulcer regime had only a transient effect.

During the following six months, melaena recurred and increasing lassitude developed and the patient was, therefore, admitted to hospital for the fifth occasion, six years after the first admission. X-ray examination showed the stomach to be atonic, dilated and with an hour-glass constriction at the pyloric canal. There was no sign of a tumour. Delimitation between the pylorus and the duodenal cap was indistinct. Hb. 50 per cent. The gastric secretion was not investigated. *Operation:* The stomach was situated high in the abdomen. Indurated fat masses were present towards the pylorus and there was fibrous induration in the hepato-duodenal ligament and extensive formation of adhesions on the posterior surface of the stomach so that the anatomical relations were considerably obscured. When the greater curvature of the duodenum was detached from the pancreas a callous ulcer perforated. No ulceration could be found in the stomach. Microscopic examination: typical ulcer defect in the duodenum but not sign of malignancy. Post-operative left-sided bronchopneumonia and cardiac arrhythmia were treated with antibiotics and digitalis. The patient was discharged from hospital in good health 12 weeks later.

Four weeks after discharge, difficulty in swallowing, vomiting, retrosternal pain and loss of weight developed rapidly.

On the sixth admission to hospital five months after operation, X-ray examination showed the oesophagus to be greatly dilated, filled with food residue and with no peristalsis. The passage of the radio-opaque medium was interrupted six cm above the cardiac sphincter and the walls of the oesophagus were irregular. On oesophagoscopy, free passage was found down to a depth of 40 cm, with thereafter practically complete occlusion of the lumen but no visible tumour tissue. *Thoraco-abdominal operation:* a large hard tumour with ulceration was present in the cardia and for a distance down into the stomach. This tumour had invaded the left lobe of the liver and the lung along the inferior pulmonary ligament and, in addition, glandular metastases had occurred. As the tumour was not extirpable, palliative oesophago-jejunostomy was established after resection of the cardia.

Microscopically, the tumour was seen to be composed of very irregular columns and islets of spinocellular epithelial cells which showed marked parakeratosis and many mitoses. Histological diagnosis: carcinoma planocellulare cornescens.

*Case 4.*

The patient was a male aged 52 years who had experienced dyspeptic symptoms since the age of 16 years. During the past year, the condition had deteriorated and signs of pyloric stenosis had developed.

Hb. 98 per cent. Ewald's test meal showed hyperchlorhydria. X-ray examination of the stomach showed slight dilatation of the body of the stomach while the pylorus and the duodenal cap did not fill. A niche-like spot, corresponding to the bulbous, was present. Eight hours later, there was moderate retention in the stomach. *Operation:* The stomach was dilated and somewhat hypertonic with adhesions to the liver and the falciform ligament. In the region of the pylorus an ulcer-tumour somewhat larger than a walnut was found intimately adherent to the pancreas. Induration was present around the bile duct and palliative resection by Finsterer's method was performed. The resected segment of the stomach did not show any abnormality.

Following operation, the patient was completely free from symptoms and fit for work for 2½ years. Thereafter, marked pain under the left rib margin unrelated to meals developed during the course of three weeks. The patient also experienced nausea, loss of weight and pale bulky motions and was, therefore, re-admitted to hospital. X-ray examination of the stomach did not reveal any abnormality and passage through the anastomosis was normal. Ewald's test meal showed achlorhydria. The other laboratory investigations did not reveal any abnormality. The condition was interpreted as chronic pancreatitis. Improvement took place following treatment with diet.

Six months later, the patient was re-admitted on account of marked abdominal pain. The clinical, laboratory, and radiological investigations did not reveal any sign of malignant disease and the patient was, therefore, transferred to a neurological department for sympathectomy by Peet's method. The condition remained unchanged after operation. The patient died three weeks later after an explorative laparotomy.

*Autopsy:* a tumour as large as a tangerine orange corresponding to the body of the pancreas was encountered beneath the site of the gastric resection. The anastomosis had a lumen approximately of the diameter of a pencil, the mucosa was normal but the adventitia had been converted into a thick ring approximately three mm thick. Microscopic examination of the tumour of the pancreas proved it to be a carcinoma of the pancreas. Microscopic examination of the anastomosis showed normal mucosa and the adventitia had undergone fibrous thickening with tumour infiltration particularly in the lymph channels from the adenocarcinoma.

## DISCUSSION

Following resection of two thirds or three quarters of the stomach for duodenal ulcer, achlorhydria occurs in the majority of cases. If the achlorhydria does not develop primarily, gastritis may develop in the remaining segment of

the stomach with subsequent atrophy of the mucosa and resulting achlorhydria. The extent to which this alteration in the secretory function following resection predisposes to carcinoma is difficult to estimate (Kühlmayer, Dalseth, Leren). Reports concerning the development of carcinoma on the basis of achlorhydria are available in the literature. In this connection, Mosbech & Videbæk have emphasized the frequency of cancer of the stomach in patients suffering from pernicious anaemia, but, on the other hand, carcinoma of the stomach is known to occur in patients with normal and even hyperchlorhydria.

If the acidity is retained following resection, peptic ulcer may occur in a certain number of cases at the anastomosis. This is, as a rule, not malignant but if, after the elapse of many years, dyspepsia develops in a patient who has undergone resection and if X-ray examination shows a niche at the site of the anastomosis or afferent loop obstruction (Berry et al.), carcinoma should be suspected.

In cases of gastric ulcer, the secretory changes following resection are not so pronounced as normal or hypo-secretion of acid may be found pre-operatively. Gastric ulcers may undergo malignant changes in a not inconsiderable number of cases. Klein calculated that malignant changes occurred in 5 per cent of the cases, Dahl-Iversen in 12 per cent, Welch in 14 per cent and Finsterer in 24 per cent. When the resection is not sufficiently radical, it is possible that the carcinoma develops from residual ulcer tissue.

In Case 1 the possibility of residual ulcer tissue cannot be excluded (the resection was undertaken three cm above the edge of the ulcer) and even although microscopic examination showed normal conditions, malignant degeneration may have occurred in ulcer tissue left at operation.

In Cases 2 and 3 the course of the ulcer disease had been characterized by the presence of several ulcers in the duodenum and in the stomach with periodic flaring-up of the activity of one of the ulcers. Ordinary X-ray examination did not reveal any abnormality in the cardia. The brief symptom-free periods suggest that, at the time of operation, changes must have been present either in the form of a peptic ulcer with a tendency to or manifest malignant degeneration, or a co-existing cancerous process.

It has been stressed by various authorities that the development of cancer following gastric resection is rare because the site of election, viz, the pyloric region is removed at resection. Approximately 30 per cent of patients suffering from peptic ulceration have both gastric and duodenal ulcers and the activity of the ulcers varies (Aagaard, Andreassen & Kurz). The most frequent site of co-existing ulcers is in the pyloric region but a certain number of cases with

duodenal ulceration is associated with ulceration of the body of the stomach. A possibility is therefore present that, following resection for duodenal ulcer, a gastric ulcer may be left in some cases. The extent to which the secretory changes tending towards achlorhydria or hypochlorhydria following resection determine the future fate of such an ulcer can only be the subject of speculation at present. The frequency of development of carcinoma on the basis of an ulcer of the stomach is stated by Dahl-Iversen to be 7 per cent in the case of juxta-pyloric ulcers and 15.7 per cent in ulcers of the body of the stomach.

No reports are available in the literature concerning the incidence of ulcer carcinoma in the cardia but the frequency of carcinoma of the stomach localized to the cardia is given as 14 per cent (Andreassen).

Case 4 showed the development of carcinoma in the gastric stump on account of infiltrative growth from a pancreatic carcinoma.

#### CONCLUSION AND SUMMARY

In contrast to the reports in the literature, carcinoma in the gastric stump in a material of 531 patients was found to have occurred in four cases from some months to four and a half years after gastric resection. This observation supports the theory that, in two out of four cases encountered, the carcinoma had developed by malignant degeneration of a gastric ulcer left at operation. One case with an ulcerated carcinoma in the cardia was not recognized at operation, while, in the fourth case, the carcinoma in the gastric stump consisted of infiltrative metastases from a carcinoma of the pancreas.

Follow-up examination of patients subjected to gastric resection from 8—20 years previously did not confirm the reports concerning the increasing incidence of the development of carcinoma in the gastric stump in patients in whom gastric resection had been undertaken for peptic ulceration.

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DUPLICATIONS IN THE GASTRO-INTESTINAL TRACT IN CHILDREN

By ERIK ROSTGAARD CHRISTENSEN

Various papers have been published concerning duplications in the gastro-intestinal tract. The first article from Denmark was by Gjørup in 1934 and only one collected work has hitherto appeared, that of Gross, Hallcomb, Georg & Faber (1952) who published a report of 58 cases from The Boston Children's Hospital treated during the years 1928—50. The Scandinavian literature on the subject is very limited and, as the correct diagnosis and treatment are of vital significance for the patients, a brief review of the literature supplemented with reports of six cases may therefore be of interest.

DEFINITION

According to Gross (1952) duplications are defined as spherical or tubular structures containing smooth musculature in the walls and lined with mucosa which are intimately connected with a segment of the gastro-intestinal tract.

PATHOLOGICAL ANATOMY

Duplications may occur in the entire alimentary canal from the base of the tongue to the anus. Gross et al. found that the most frequent site was the ileum (Table 1).

Table 1.  
Distribution of 58 cases of duplication in the alimentary tract from Boston Children's Hospital.

|   |    |
|---|----|
| Base of tongue .....                            | 1  |
| Intrathoracic:                                  |    |
| from oesophagus .....                           | 13 |
| from duodenum or ileum .....                    | 3  |
| Stomach .....                                   | 2  |
| Duodenum .....                                  | 4  |
| Jejunum .....                                   | 4  |
| Ileum .....                                     | 19 |
| Ileo-caecal valve .....                         | 8  |
| Caecum .....                                    | 3  |
| Terminal ileum or colon with separate mesentery | 2  |
| Sigmoid colon .....                             | 2  |
| Rectum .....                                    | 3  |
| Double-barrelled colon or rectum .....          | 4  |

The duplications vary considerably in form and size, from small formations which resemble diverticuli to large closed cysts. Spherical or oval hollow organs originating from the alimentary canal and occasionally communicating with it are the most frequent. Occasionally these lie close up to the corresponding segment of the intestine so that this is actually double-barrelled. A common feature of all of the forms is that they are attached to a varying degree to the segment of the intestine from which they originate and that they always contain smooth musculature in the wall as op-

posed to chylous and mesenteric cysts. The duplications are lined with mucosa from the alimentary canal but this is not necessarily of the same type as the mucosal lining of the segment to which they are attached topographically. Thus, a cyst at the base of the tongue may be lined with colonic mucous membrane and a duplication of the rectum with gastric mucosa (Gross 1952, Clift 1954). Further, several types of mucosa may occur in one duplication and ectopic pancreatic tissue has been described (Fischer 1950, Tyroll 1944). The content is, as a rule, clear colourless mucus secreted by the mucosa of the duplication itself. If pancreatic tissue or gastric glands are present in the walls, the fluid may have varying pH and show enzymatic activity. If the duplication communicates with the alimentary canal, faeces or gas may be present. As the majority of duplications are closed, excessive pressure in the cavity frequently develops with necrosis of the wall and haemorrhage as sequelae.

EMBRYOLOGY

Various theories have been presented in the course of time to explain the mode of development of duplications (cf. Gross and McLetchie et al. 1954). One of the most plausible theories was presented by Louis & Chicie who found that diverticulæ frequently occurred in various segments of the alimentary canal both in the human foetus and in the embryonic forms of various other animals. Normally, these disappear during development, but if an isolated diverticulum remains and becomes cut off from the original segment of the intestine a duplication may develop. Brenner based another theory on a singular condition in the embryology of the alimentary canal. At an early stage of foetal life, the alimentary canal consists of a solid column of cells in which cystic cavities develop and later fuse to become a continuous lumen. If an isolated cavity fails to communicate with the others, according to Brenner, a duplication is formed.

MATERIAL

The material consists of six patients admitted to the Department of Paediatrics during the years 1950—58, and varying in age from two days to 13 years. In two of the children, the site of the duplication was the stomach, in two the small intestine, in one the rectum while in one case duplications of both the colon and the rectum

From the Department of Paediatric Surgery, (Surgeon-in-Charge: C. C. Winkel Smith), the Department of Paediatrics (Prof. P. Plum), and the Department of Radiology (Prof. Gregers Thomsen), Rigshospitalet, University of Copenhagen.

were present. All six of the patients were submitted to radical operation and were alive on follow-up examination with normal alimentary function. In one infant with duplication of the rectum, treatment is not yet complete as a corrective cosmetic operation is still required.

#### CASE HISTORIES

*Case 1*, boy, son of a widow, only child. Birth weight 3625 g (8 lbs.). The boy was healthy until the age of ten years when he was admitted to another hospital on account of headache, fatigue, loss of appetite and melaena. X-ray examination of the thorax, stomach and colon rendered normal results and only slight anaemia and leucopenia and blood in the stools were found. At the age of 13 years, the boy was re-admitted to the same hospital following loss of consciousness on account of marked melaena. Anaemia was again found with a haemoglobin of 38 per cent and a positive benzidine reaction in the faeces. Passage through the small intestine was normal. The boy was transferred to the Department of Paediatric Surgery after two months. X-ray of the stomach, intestinal follow-through, barium enema and rectoscopy did not disclose any abnormality. On the provisional diagnoses of Meckel's diverticulum or duplication, explorative laparotomy was undertaken. At the transition between the upper and middle thirds of the small intestine a duplication the size of a small apple was encountered in the mesentery. This was resected together with the attached intestine. End-to-end anastomosis was established and the post-operative course was smooth. Microscopic examination revealed small intestine with ectopic gastric mucosa. The boy was in good health on follow-up examination.

*Case 2*, boy, son of an innkeeper and number six of six siblings. The delivery and early development had been normal. From the age of one year, the appetite had been poor and increasing vomiting had occurred. The vomit had been greenish on a single occasion but was otherwise alimentary. The general practitioner found a tumour as large as a hen's egg in the epigastrium and the child was, therefore, admitted at the age of 1½ years. X-ray examination of the stomach showed a soft-tissue tumour the size of a clenched fist above and behind the stomach. Intravenous urography was normal. No blood was present in the faeces and the other laboratory investigations showed normal results. Laparotomy revealed a duplication of the stomach as large as an orange intimately connected with the pylorus and extending up in the lesser omentum almost to the porta hepatis. The tumour was intimately connected with the stomach which had to be removed for an extent of six cm. from the angle to distal to the duodenal bulb. End-to-end anastomosis was established between the stomach and the duodenum. Microscopic examination of the duplication showed gastric mucosa. The post-operative course was smooth. On control examination five years later, the child was thriving and had developed normally and had experienced no dyspeptic symptoms whatsoever. The results of blood investigations were normal. X-ray examination revealed normal passage through the stomach.

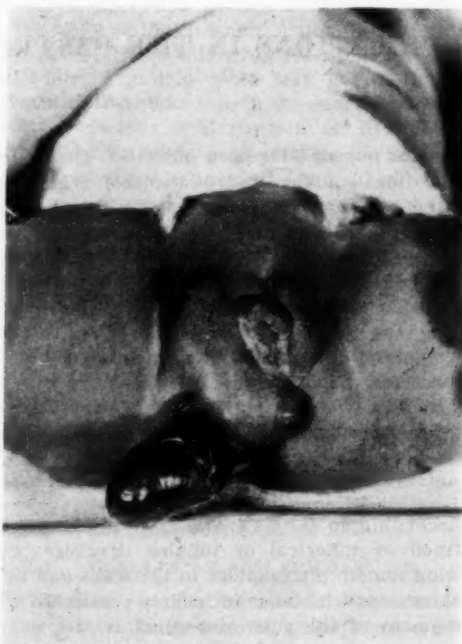


Fig. 1.  
*Girl aged two days with a duplication of the rectum covered with partly ulcerated skin.*

*Case 3*, girl, daughter of a doctor. Only child. Pregnancy and delivery were normal. Birth weight 3200 g (7 lbs.). On account of failure to thrive and persistent small regurgitations after every feed but no real vomiting, the infant was admitted to another hospital at the age of four weeks. As pyloric stenosis was suspected six drops of eumidine were administered before the feeds but, after the elapse of a few days, a tumour as big as an orange was felt in the abdomen. This tumour extended from the left costal margin to the pubic symphysis. The infant was, therefore, transferred to this department. Laparotomy showed a large tense duplication of the stomach attached to the fundus of the stomach superiorly and ending blindly at the lower edge of the pancreas. The entire free part of the duplication was extirpated while the upper part was anastomosed end-to-side with the stomach for a distance of 2—3 cm. The post-operative course was uneventful. Post-operative X-ray examination showed that the form, position and emptying of the stomach were normal.

*Case 4*, boy, son of a driver. Delivery normal. Birth weight 3300 g (7 lbs. 4 oz.). The infant was breast-fed for six months and thrived well. After weaning to artificial feeding increasing constipation occurred and the circumference of the abdomen increased. Eventually laxatives and enemata were necessary daily. In addition, a tendency to vomiting developed. The vomits were alimentary and never contained bile pigment. Following two episodes of incomplete intestinal obstruction the child was admitted, at the age of two years, with the provisional diagnosis of congenital megacolon. Barium enemata revealed a greatly dilated colon and in the true pelvis a soft-

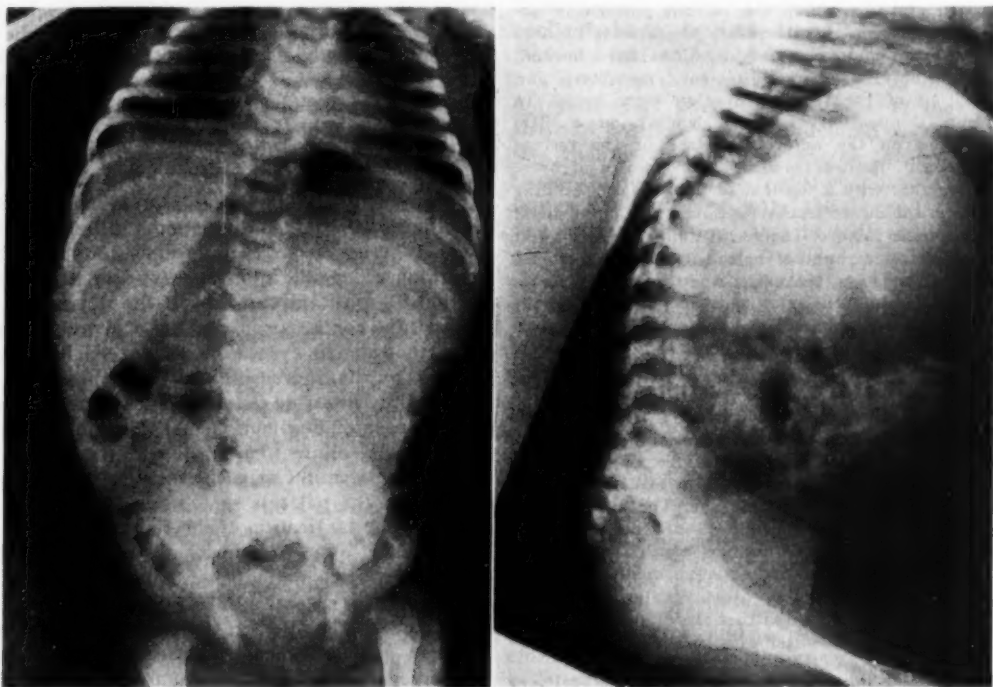


Fig. 2.

*Girl aged five weeks with a duplication of the stomach.*

*On straight X-ray the distended stomach is dislocated anteriorly and the colon transversum downwards.*

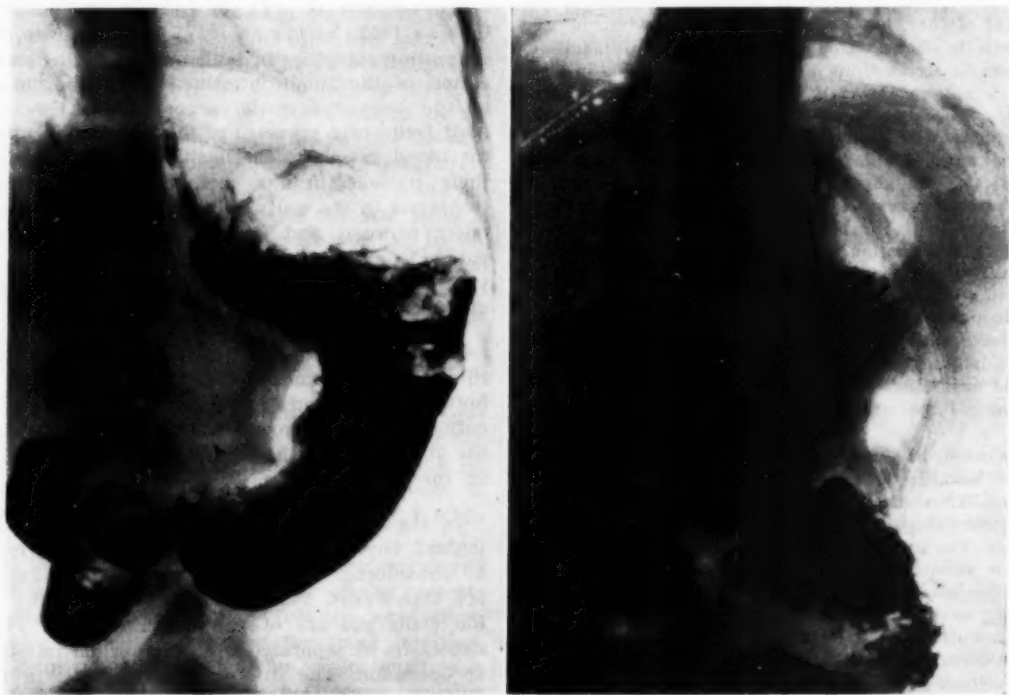


Fig. 3.

*a) Boy aged 1½ years with a duplication of the stomach. Large swelling on the lesser curvature displaces the stomach to the left.*

*b) Same patient as in Fig. 3 a five years after the operation. The stomach is normal.*

tissue tumour displacing the rectum posteriorly towards the sacrum was revealed. The results of urography, blood and urine investigations were normal. At laparotomy, a common ileo-colic mesentery and duplication of the transverse colon were found. In addition, duplication of the appendix and a little duplication on the anterior surface of the rectum were present. Both appendices were resected at operation together with a segment of the dilated ascending colon and the entire transverse colon to a point distal to the splenic flexure. The rectal duplication was left untouched. On account of episodes of incomplete intestinal obstruction, the patient was submitted to re-operation two months later and the remainder of the dilated colon was removed and end-to-end anastomosis established between the ileum and the sigmoid colon. On this occasion, the child made a rapid recovery and was discharged in good condition with soft to formed stools twice to thrice daily. The child was re-admitted for control and on account of defective growth in length at the ages of three and ten years. At the age of nine years the child measured 35 cm less than the average for his age. The clinical condition was satisfactory and all of the laboratory investigations rendered normal results. A barium meal showed that the radio-opaque medium reached the dilated sigmoid colon already after two hours. Rectal examination showed that the duplication of the rectum had become softer and smaller.

*Case 5, girl, daughter of a joiner. Normal delivery in The University Hospital. Birth weight 3000 g (6 lbs. 9 oz.). The infant was transferred at the age of two days on account of a firm tumour about five cm in length and as thick as a thumb situated to the right of the anus. The skin covering the tumour was partially ulcerated and very thin (Fig. 1). In addition, immediately in front of the anus a swelling as large as a nut and covered with normal skin was found and a poorly delimited soft-tissue swelling of the right labium majus. The tumour which was connected in its deeper part with the rectum was encircled by an incision and removed. Microscopic examination revealed tissue from the skin containing colonic wall. The post-operative course was smooth. X-ray examination of the spine and pelvis did not reveal any sign of skeletal deformity. Control examination when the child was two months of age showed a double-barrelled anus in addition to the intumescences which were left in front of the anus and in the labium majus. Thus, duplications of the rectum and anal canal were concerned. The former had been removed but not the latter.*

*Case 6, boy, son of a traffic policeman. The child was number two of two siblings. The delivery was normal and the birth weight 2600 g (5 lbs. 11 oz.). Delivery occurred three weeks before the expected date. The infant did not thrive well from the age of two months and melaena and occasionally macroscopic blood was observed on the stools. The infant was admitted to another hospital where a blood transfusion was administered on account of anaemia. On account of persistent anaemia and intestinal haemorrhage the infant was transferred at the age of three months. As X-ray examinations of the gastro-intestinal tract employing radio-opaque media both orally and per rectum did not reveal any pathological changes, an explorative laparotomy was performed*

during which a duplication of the small intestine approximately 50 cm in length at about the middle of the jejunum was found. This duplication was successfully removed without resection of normal intestine. The post-operative course was completely smooth.

#### DISCUSSION

Duplication most frequently becomes apparent in early childhood but has also been described at all ages (Gross). The patients in this material varied in age from two days to 13 years. The symptoms depend upon the type of the duplication, its position and size. If the duplication is closed, the continual production of secretion from the mucosa will eventually produce a large cyst which by its increasing growth will compress the healthy intestine causing obstruction and pain. In the case of duplication of the colon, this may produce a clinical picture which greatly resembles congenital megacolon. This was the case in one of the patients in the present material. A co-existing duplication of the rectum was without significance for the massive dilatation of the colon. The two patients with duplication of the stomach also showed clinical signs of obstruction as they had retention in the stomach with vomiting. In one of the cases, coffee-ground vomiting occurred and the presence of blood was verified by a positive benzidine reaction. Haemorrhage from the gastro-intestinal tract in the form of haematemesis and melaena is another very common symptom (Clift 1954, Dórován 1947, Gross 1952, Seifert 1957). Melaena was the presenting symptom in both patients with duplication of the small intestine. The pathogenesis of the haemorrhage is, according to Gross, most frequently pressure of the duplication upon the blood vessels to the healthy intestine during their passage in the mesentery. This causes ischaemia in the wall of the intestine with subsequent necrosis and haemorrhage. If the duplication contains functioning gastric mucosa, a peptic ulcer may develop and cause haematemesis or melaena.

Duplications may frequently be felt as tumours through the abdominal wall. This was the case in both of the patients in this material with duplications of the stomach. In the newly-born girl the duplication of the rectum was directly visible in the perineum.

In the differential diagnosis, Meckel's diverticulum, chylous cysts and mesenteric cysts must be considered. The latter, according to Gross, are thin-walled cysts devoid of musculature in the walls and are of lymphogenic origin. They can easily be separated from the normal intestine at operation. The differential diagnosis, in the author's opinion, may frequently be particularly difficult at operation and the diagnosis is frequently not established until microscopic examination has been undertaken.



## RADIOLOGICAL FINDINGS

A thorough X-ray examination is frequently of great diagnostic value. A straight X-ray photograph supplemented with radio-opaque media orally or per rectum may frequently arouse suspicion of a duplication and indicate its size, position and relation to surrounding structures. Small duplications which do not communicate with the lumen of the intestine will, in the majority of cases, be impossible to demonstrate radiologically and the intestinal passage in the two patients in this material with duplication of the small intestine was also completely normal. Large duplications on account of the obstructing effect upon the intestine or stomach may occasionally be diagnosed in the straight X-ray. In the girl aged five weeks with duplication of the stomach, the distended stomach could be distinctly seen anteriorly (Fig. 2). On account of poor general condition and marked gastric retention, it was not possible to administer radio-opaque medium orally, but a barium enema showed normal conditions. X-ray photographs of the stomach filled with radiopaque medium after operation showed it to be of normal size, shape and position and free passage through the stomach was present. The boy aged 1½ years with duplication of the stomach received radio-opaque medium orally prior to operation and the pictures revealed a soft-tissue tumour as large as a clenched fist on the lesser curvature which displaced the stomach anteriorly and to the left (Fig. 3 a). X-ray photographs five years after operation did not show any abnormality (Fig. 3 b). The clinical suspicion of Hirschprung's disease could be discarded in the boy aged two years with duplication of the colon and the rectum as both the passage through the intestine and barium enema pre-operatively revealed massive dilated coils of colon but no constricting segments and the mucosal pattern, haustrations and peristalsis were normal. In the lateral picture, the little duplication of the rectum could be seen as a soft-tissue tumour the size of a tangerine in the true pelvis and displacing the rectum towards the sacrum.

## TREATMENT

Treatment of duplications is always surgical and most frequently consists of resection of the duplication and the attached segment of the intestine and primary end-to-end anastomosis to establish continuity (Fischer 1950, Hoffman 1957, Ladd & Gross 1940, Laszlo 1957 and others). This method was employed with satisfactory results in four of the patients in this material, while in the girl aged three months with duplication of the small intestine, the duplication which was 50 cm in length was successfully separated from the normal intestine by meticulous dissection so that resection of the normal intestine was avoided. In other cases, very extensive resection may be necessary and,

in such cases, marsupialization is to be preferred particularly in debilitated and very ill children (Gross and other authors).

Apart from the clinical condition of the child, the individual conditions as regards the type, size and position of the duplication may necessitate changes in the technique of the operation. Large duplications of the stomach may be so intimately connected with the normal stomach that radical excision must include simultaneous gastrectomy. Ladd & Gross recommend that in such cases either the stomach should be anastomosed to the duplication or part of the duplication should be removed and the remainder should be sewn to the anterior abdominal wall as in marsupialization. In one case in this material, a modification of this technique was employed as drainage of the duplication was obtained by end-to-side anastomosis to the stomach and the functional result was entirely satisfactory.

## CONCLUSION

Duplications of the alimentary canal may become apparent at all ages but most frequently in infants and small children. The symptoms depend upon the position and, as this is frequently in close relation to the mesentery, every case of intestinal obstruction and haemorrhage from the gastro-intestinal tract, even in newly-born infants, should arouse suspicion of the presence of duplication. The prognosis is good with timely paediatric surgery with antibiotic cover and meticulous maintenance of the fluid balance.

## SUMMARY

Following a brief review of the literature, the result of six cases of duplication of the stomach and intestine treated by radical operation are presented. The patients varied in age from two days to 13 years. All of them are alive and without any dyspeptic symptoms on follow-up examination.

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## A NEW AGGLUTINATION REACTION IN THE DIAGNOSIS OF RHEUMATIC DISEASES

### THE HYLAND RA-TEST

By KNUD ELDON, NIELS V. JARLØV and B. STRANDBERG

The symptomatology in the early stage of rheumatoid arthritis (stage I) presents an exceedingly motley picture, in contrast to the conditions found in later stages (stages III & IV), in which the diagnosis can be made with certainty, solely on the basis of the physical examination. It is of decisive importance for treatment that the diagnosis of rheumatoid arthritis should be made while the disease is still in its initial stage, particularly if the administration of steroids is contemplated. An early diagnosis is of special significance in the differential diagnosis from the non-rheumatic diseases, by no means few, which may present with arthritic conditions closely resembling those of rheumatoid arthritis (endocarditis lenta, reticulum cell sarcoma, hypernephroma and other forms of cancer, and certain pulmonary diseases). Among the degenerative joint diseases it may be difficult to distinguish acute menopausal osteoarthritis from incipient rheumatoid arthritis.

Rheumatoid arthritis in its initial stage is diagnosed by comparing history and physical examination with roentgenographic findings and laboratory investigations; among the latter, sero-reactions for demonstrating present or past streptococcal infection will usually find a prominent place. The various laboratory investigations are individually of doubtful value, however, as none of the reactions so far used can be regarded as specific for rheumatoid arthritis or rheumatic disease.

In recent years, attention has increasingly been directed to various agglutination reactions for demonstrating the "rheumatoid factor" or RF (Svartz 1956); this is a serum protein which is mainly found in patients with rheumatoid arthritis, and to some extent it behaves as an antibody against certain  $\gamma$ -globulins. Sera containing RF agglutinate particles or erythrocytes which have been covered with these  $\gamma$ -globulins. The sensitivity and specificity of the various tests depend on the choice of  $\gamma$ -globulin and the technique otherwise employed. Many investigations of this kind have been performed with

erythrocytes covered with a  $\gamma$ -globulin which was itself an antibody, *e.g.*, sheep erythrocytes treated with a rabbit serum containing antibodies against sheep erythrocytes (Waller 1940, Rose et al. 1948), or Rh-positive human erythrocytes treated with a non-agglutinating human anti-Rh serum (Waller et al. 1956). Tanned erythrocytes coated with  $\gamma$ -globulin from Cohn's fraction II (Heller et al. 1954) have also been used. These procedures are cumbersome and time-consuming, however, as the erythrocytes must be coated with the  $\gamma$ -globulin immediately prior to the actual test with the patient's serum.

Later investigators have succeeded in binding fraction II  $\gamma$ -globulin to colloidal bentonite particles (Bozicewich et al. 1958) and to artificially produced latex particles (Singer et al. 1956). The same disadvantages as those of the erythrocyte techniques are inherent in the Bentonite methods, but Singer's  $\gamma$ -globulin-coated latex particles constitute a reagent which is stable at 2–10° C for a period of months, and can thus be distributed in a condition ready for use. The latex-globulin reagent is made by Hyland Laboratories, Los Angeles\*), which also market a glycine-saline buffer diluent for diluting the sera to be examined. The test is called the Hyland RA-Test. The technique is simple:

One drop of patient's serum is mixed with 20 drops (1 cc) of glycine-saline buffer diluent. One drop of the dilution is placed on a slide and one drop of latex-globulin reagent is added. After mixing, the slide is tilted from side to side for one minute and the result is read with the naked eye, preferably against a black background.

The reading involves no difficulties, as positive reactions appear as an obvious agglutination, and doubtful reactions occur only rarely. In the following survey of results, the sole distinction is between positive and negative reactions, but it may be useful to evaluate the strength of the reaction by distinguishing between strong, medium and weak positive reactions. It is recommended always to include a known positive and negative serum in the test run. For this purpose

From Nordisk Insulinlaboratorium, Gentofte, and Copenhagen County Hospitals in Glostrup and Gentofte, Depts. of Physical Medicine and Rheumatology.

\*) supplied in Denmark by A/S Emborg.

Table 1.

Distribution of RA positive and RA negative reactions among 52 patients and 91 controls.

| Diagnosis                             | Number | RA positive | RA negative |
|---------------------------------------|--------|-------------|-------------|
| Rheumatoid arthritis.                 | 45     | 41 (91%)    | 4 (8.9%)    |
| Rheumatoid arthritis?                 | 4      | 0           | 4           |
| Spondylitis<br>anchylopoetica . . . . | 3      | 3           | 0           |
| Controls . . . . .                    | 91     | 5 (5.5%)    | 87 (94.5%)  |

Hyland Laboratories market control sera in sterile dilutions ready for use, stable at 2–10° C. However, it is cheaper to use dilutions of positive and negative sera from previous tests in the laboratory. Such sera and dilutions retain their activity well when stored frozen.

The aim of this study is a comparison between the RA-test and the seroreactions currently used in the diagnosis of rheumatic diseases in this country. These seroreactions are

- 1) Antistreptolysin titre (AST).
- 2) Antistreptococcal hyaluronidase (ASH).
- 3) Streptococcal agglutination titre (SAT).

The following investigations have also been carried out:

- 4) Erythrocyte sedimentation rate (ESR).
- 5) Haemoglobin percentage (Hb %).
- 6) Serum albumin/globulin ratio (electrophoresis), with special regard to the increase in  $\alpha_2$ -globulin and  $\gamma$ -globulin in rheumatoid arthritis.

RA-tests have been performed in 143 patients, 45 of whom had rheumatoid arthritis.

It is seen that four uncertain cases were RA-negative, and three cases of ankylosing spondylitis were RA-positive.

The 91 control reactions were performed in patients with predominantly para-rheumatic diseases (osteoarthritis, spondylitis, intervertebral disc diseases, etc.) so that in many of the cases the diagnosis of rheumatic disease had had to be considered. We believe that this way of selecting the control material leads to a better evaluation of the individual reactions in that category of patients usually referred to a physiotherapeutic department. The four "false" negative reactions were found in the following patients:

- 1) A 44-year-old woman with typical stage I rheumatoid arthritis of four months' duration. ESR was 39 mm and ASH 7000 (doubtfully elevated).

Table 2.

AST, ASH and SAT reactions in the rheumatoid arthritis cases and the controls.

|                         | Test | Number | Positive | Per cent |
|-------------------------|------|--------|----------|----------|
| Rheumatoid<br>arthritis | AST  | 45     | 3        | 6.7      |
|                         | ASH  | 44     | 7        | 15.9     |
|                         | SAT  | 43     | 22       | 51.2     |
| Controls                | AST  | 62     | 7        | 11.3     |
|                         | ASH  | 62     | 7        | 11.3     |
|                         | SAT  | 53     | 6        | 11.3     |

- 2) A 56-year-old woman with rheumatoid arthritis which had progressed very slowly over a period of 27 years. ESR was 26–40 mm and the other blood tests were normal.
- 3) A 30-year-old woman with slight joint symptoms for two years. All blood tests were normal.
- 4) A 41-year-old woman with a clinical diagnosis of incipient rheumatoid arthritis, but in whom the subsequent course was more suggestive of rheumatic fever. AST 500–800 (elevated), ASH 75,000–85,000 (very strongly elevated), and SAT positive. Patients nos. 1) and 2) had undoubtedly rheumatoid arthritis, and no. 4) probably rheumatic fever.

The five "false" positive reactions (Table 1) were found in the following patients:

- 1) A 71-year-old man with diabetes and polyarticular osteoarthritis. All blood tests normal.
- 2) A 70-year-old man with pain in knee- and ankle-joints for five years. All blood tests normal.
- 3) A 60-year-old woman who had been treated with gold salts ("Sanocrysin") for rheumatoid arthritis a few years previously. At present the disease is completely inactive and all blood tests are normal.
- 4) A 56-year-old woman with osteoarthritis of the hip and elevated ESR. In 1945 she had arthritis after tonsillitis.
- 5) A man with endocarditis lenta and arthritis.

Case histories Nos. 3 and 4 show typical rheumatic symptoms, patient No. 3 had probably rheumatoid arthritis.

The figures for "false" negative (8.9 per cent) and "false" positive reactions (5.5 per cent) in Table 1 may have been calculated too high, as one of the negative and two of the positive reactions can hardly be described as "false".

Table 3.

A comparison of the ESR level in the rheumatoid arthritis cases and the controls. The first estimation made when admitted to hospital is used as ESR.

| ESR (mm/hour)         | 0–14 | 15–29 | 30–44 | 45–59 | 60–74 | 75–89 | 90–104 | 105–119 | > 120 |
|-----------------------|------|-------|-------|-------|-------|-------|--------|---------|-------|
| Rheum. arthr. . . . . | 10   | 15    | 25    | 15    | 12.5  | 15    | 2.5    | 5       | 0 %   |
| Controls . . . . .    | 59.4 | 26    | 6.2   | 3.1   | 0     | 0     | 2.1    | 2.1     | 1.1 % |

Table 4.

A comparison of the haemoglobin percentage in the rheumatoid arthritis cases and the controls.

| Haemoglobin %      | 100-86 | 85-71 | 70-56 | 55-40 | Percentage below 86 % |
|--------------------|--------|-------|-------|-------|-----------------------|
| Rheum. arthr. .... | 9      | 11    | 9     | 1     | 70.0                  |
| Controls .....     | 54     | 14    | 1     | 0     | 27.8                  |

Table 2 shows the results of the AST, ASH and SAT-reactions. Only the SAT test appears of any value, with 50 per cent positive reactions in patients with rheumatoid arthritis and about 11 per cent "false" positive reactions.

Table 3 shows the ESR in the two groups of patients. This distribution agrees closely with that in Kahlmeter's study in 1938. The result of the haemoglobin estimations in the two groups is seen from Table 4.

Elevated  $\alpha_2$ - and  $\gamma$ -globulin in serum are non-specific for rheumatoid arthritis, but it appears as if elevated  $\alpha_2$ -globulin has a certain diagnostic value in the disease. Electrophoretic study of the serum proteins in 30 of the patients with rheumatoid arthritis showed elevated  $\alpha_2$ -globulin in 50.0 % and elevated  $\gamma$ -globulin in 36.7 %.

In Table 5, the "positive" reactions in the two groups are compared. The RA-test is clearly seen to be superior by far to the other tests. SAT has a considerable diagnostic value, the reduced haemoglobin percentage likewise. The increase in  $\alpha_2$ -globulin possibly also plays a part, but unfortunately we still do not have a sufficient number of examinations of this special control material, to be able to elucidate the question.

#### SUMMARY

An account is given of the prerequisites for and the technique of an agglutination test for demon-

Table 5.

A comparison of all "positive" reactions in the two groups.

|                                 | Rheum. arthr. | Controls. |
|---------------------------------|---------------|-----------|
| RA positive .....               | 91.1          | 5.4       |
| ESR > 15 mm .....               | 90.0          | 40.6      |
| Haemoglobin < 86 % .....        | 71.5          | 27.8      |
| SAT positive .....              | 51.2          | 11.3      |
| $\gamma$ globulin > 20 % .....  | 36.7          | ?         |
| $\alpha_2$ globulin > 9 % ..... | 50.0          | ?         |

strating the Rheumatoid Factor in serum (the RA-test). The results of 143 RA-tests performed in 45 patients with rheumatoid arthritis and 91 controls, show that the RA-test is positive in at least 91 per cent of the patients with rheumatoid arthritis as against 5.5 per cent of positives in the control material. The diagnostic value of the RA-test is also compared with the following tests: Erythrocyte sedimentation rate, haemoglobin percentage, antistreptolysin titre, antistreptococcal hyaluronidase, streptococcal agglutination titre and fractionated serum-protein investigation.

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#### BOOKS

### THE HOSPITAL SURVEY OF DENMARK

By MARIE LINDHARDT

In 1958 The Committee on the Danish National Morbidity Survey published a comprehensive statistical analysis of the utilization of medical-surgical hospitals in Denmark. An English translation of this book, *The Hospital Survey of Denmark*, followed in 1959.

This book of 201 pages contains 17 chapters, a summary, 56 text tables, 14 charts, and a second part consisting of 7 detailed tables and a few appendices. It reports a thorough analysis of the utilization of Danish hospitals in 1952/53 as well as a retrospective study of the utilization in 1930.



The studies were prompted by the extensive changes that have taken place in hospital utilization in the course of the past few decades, changes which had not so far been elucidated numerically. At the initiative of The National Health Service, the above-mentioned Committee was appointed, and the expenses of the investigation were defrayed by the Rockefeller Foundation, private Danish institutions, and the Danish Government. In other respects, the World Health Organization, Regional Office for Europe, afforded valuable assistance towards completing the work.

The statistical data were collected by sampling methods. In the 1952/53 study, individual data were obtained for 27,000 patients over 15 years of age (children were not included) discharged from public hospitals distributed over the whole of Denmark. This corresponds to about 10 per cent of the patients admitted to medical-surgical departments in the course of one year. The 1930 study comprised approximately 6000 adult patients or 6 per cent of the total during that year. A questionnaire was set up, and after a pilot study had been conducted, the Committee started compiling the material by the aid of a travelling team consisting of a doctor, a statistician, and clerks who visited all the departments at intervals on instruction and inspection rounds.

The questionnaire, completed partly by the hospital doctors when the patient was admitted and discharged, partly by the nurse in charge of the department, and lastly by the travelling team, comprised numerous data of medical and social nature. The most important results will be reviewed below:

In 1952/53 39.4 per cent and in 1930 40.9 per cent of all admitted patients were males. A finding worthy of note, however, is the relatively marked increase in the number of women between 20 and 40 which had occurred during the two decades intervening between the two studies. It is explicable by the increased tendency to treat minor female complaints as well as deliveries without complications in hospital. Moreover, it is evident that the hospitals, especially the medical departments, are being occupied ever more by elderly people. This increase by far exceeds the changed age structure among the total population. As regards marital status the frequency of admissions was higher among single than married males, while among the females it was higher among those who were married.

As far as the male patients are concerned, the material was grouped according to occupation: Self-employed, salaried employees, and wage-earners. This analysis showed a considerably higher frequency of admissions among the wage-earners than among the other two groups, due mainly to accidents and rheumatic diseases and, among elderly wage-earners, also heart disease.

Diagnostic grouping of the admitted patients was undertaken according to the International Classification of Diseases of 1948. On this basis, two condensed diagnostic lists, of 99 and 33 numbers respectively, were worked out for practical statistical use. In respect to the nature of the hospital-treated diseases there has been, as might be expected, a comparatively marked increase in the typical diseases of old age during the period between the two studies. This applies to vascular lesions affecting the central nervous system, degenerative heart diseases, calculi of the urinary system, etc. — in accordance with the above-mentioned change in the age structure of the hospital population. The reason why mental disorders show no particular increase is that special departments have been set up for this category of patients and that very often neuroses and psychoses are listed as complicating diagnoses and therefore do not appear among the values representing main diagnoses. Incidentally, the development is characterized by a decrease in infectious diseases and an increase in the admissions of patients having normal deliveries and the victims of accidents (traffic accidents).

In Denmark as well as in most other countries, the duration of stay in hospital has been perceptibly reduced during the period 1930 to 1952/53. In the medical departments the average duration of stay has decreased from 30 to 20 days and in surgical departments from 26 to 14 days. After the values representing the very short stay with mild female complaints, abortions, and deliveries have been deducted from the total, it is evident that the women stay longer than the men.

A question frequently discussed among Danish doctors is whether the increasing utilization of the hospitals is due to patients being admitted for social reasons because, for some reason or other, they are unable to receive the necessary care at home. This question was answered by the 1952/53 study to the effect that 4 per cent of the admitted patients, mainly elderly persons admitted to medical departments, belong to this category.

Increasing activity in the hospitals is evident int. al. from the shorter average duration of stay. Moreover, a comparison of the two analyses shows increasing surgical activity, not least in the case of elderly patients. X-ray and laboratory investigations are also being used to an increasing extent, so that the latter are used in almost 100 per cent of the patients.

The patients' condition on discharge, assessed by the registrar or the head of the department, proved to differ widely in medical and surgical departments. While 58 per cent of the patients discharged from surgical departments were designated as cured, this percentage was only 16 in the medical departments. Adding up the groups cured and improved gives 70 per cent in

medical and 87 per cent in surgical departments. The higher mortality in medical departments, 7.7 per cent as against 3.2 per cent in the surgical departments, is most pronounced among patients under 60 years of age.

Another question which arises in connection with the condition on discharge is the fitness for work after the stay in hospital. A collected analysis comprising the different categories of department shows for the productive age groups, i. e. 15—64 years, that 67.4 per cent were fully capable of working (after a suitable convalescence), 19.8 per cent partially fit, 10.2 per cent unfit for work, 0.6 per cent helpless, and 2 per cent had died. In this respect too the results are more favourable for the surgical departments. It applies to both analyses that the condition of health as well as the fitness for work depend upon the patient's age as well as upon the nature of the disease. These factors are further elucidated by tables and charts.

The 1952/53 questionnaire included a question of current interest in Denmark: On discharge the hospital doctor was asked to state whether the admission might have been avoided, whether — providing various, specified conditions — the patient might just as well have been treated at home or on an out-patient basis. On the whole, the answers to this question show that an average of about 10 per cent might have been treated at

home without a nurse and about 8 per cent with a nurse. Out-patient treatment was stated to have been medically justified and practicable in 8 per cent. These answers are chiefly of theoretical interest, representing a medical estimate.

In addition, the book gives various other data relating to hospital treatment: The waiting time before admission, re-admissions, after-treatment, etc.

The Hospital Survey did not in every respect give the expected result, and it is only to a certain extent that it can be said to have fully clarified the utilization of the hospitals. It must be emphasized, however, that practically everywhere the medical, nursing, and administrative staffs of the hospitals showed goodwill and understanding in performing the considerable amount of work required in answering the many items of the questionnaire. Thanks to this praiseworthy contribution a large proportion of the numerical results are of lasting value and the Hospital Survey can at least afford an applicable basis for possible future analyses of a similar nature.

#### *The Hospital Survey.*

Published by the Committee on the Danish National Morbidity Survey. Munksgaard, Copenhagen 1959. 201 pages. Danish kr. 34.00.

## MEDICO-STATISTICAL INFORMATION FROM DENMARK FOR THE YEARS 1957 AND 1958

By KAREN DREYER and ERNA FRANDSEN

| Population:                          |              |  | Notifiable diseases:*)                               |                                      |
|--------------------------------------|--------------|--|--|--------------------------------------|
| Census October 1st, 1955: 4,448,401  |              |  | 1958   | 698,862 = 155 per 1,000 population   |
| Estimated, July 1st, 1958: 4,515,100 |              |  | 1957   | 1,125,385 = 251 per 1,000 population |
| Live-born:                           | 1958         | 74,681 = 16.5 per 1,000 population     | December 31st, 1957:                                 |                                      |
|                                      | 1957         | 75,264 = 16.8 per 1,000 population     | Practising physicians: 5,391 = 1 per 832 inhabitants |                                      |
| Still-born:                          | 1958         | 1,173 = 1.5 per cent of total births   | Dentists with own practice:                          |                                      |
|                                      | 1957         | 1,169 = 1.5 per cent of total births   |  |                                      |
| Deaths                               | total        | 1958 41,560 = 9.2 per 1,000 population | 1,456 = 1 per 3,082 inhabitants                      |                                      |
|                                      |              | 1957 41,730 = 9.3 per 1,000 population | Pharmacies: 351 = 1 per 12,786 inhabitants           |                                      |
|                                      | under 1 year | 1958 1,675 = 22.4 per 1,000 live born  | Practising midwives: 673 = 1 per 1,580 women         |                                      |
|                                      |              | 1957 1,758 = 23.4 per 1,000 live born  | in the age group 15—49 years                         |                                      |

Table 1.

\*) Except venereal diseases, delirium tremens and scabies.

The information in Table 1, together with that of Table 2, showing the number of reported cases of epidemic diseases, indicates a decrease of about

40 per cent in the epidemic morbidity from 1957 to 1958, mainly due to influenza of which 167,144 cases were reported in 1958 against 544,613 in 1957.

A total of 94 cases of acute anterior poliomyelitis was notified in 1958, namely 66 paralytic and

From the National Health Service, Statistical Section.  
Head: Marie Lindhardt.

Table 2.  
The epidemic morbidity in Denmark 1958 and 1957.

|   | Reported cases |         | per 100,000 pop.   |                    |
|---|----------------|---------|--------------------|--------------------|
|   | 1958           | 1957    | 1958               | 1957               |
| Typhoid fever .....                                 | 12             | 15      | 0.3                | 0.3                |
| Paratyphoid fever .....                             | 15             | 16      | 0.3                | 0.4                |
| Epidemic cerebrospinal meningitis .....             | 132            | 114     | 2.9                | 2.5                |
| Acute anterior poliomyelitis, total .....           | 94             | 16      | 2.2                | 0.6                |
| —, paralytic .....                                  | 66             | 10      | 1.6                | 0.2                |
| Epidemic cerebrospinal meningitis .....             | 21             | 34      | 0.5                | 0.8                |
| Dysentery .....                                     | 64             | 114     | 1.4                | 2.5                |
| Intermittent fever, originating in Denmark .....    | —              | —       | —                  | —                  |
| —, outside Denmark .....                            | 15             | 12      | 0.3                | 0.3                |
| Diphtheria .....                                    | —              | —       | —                  | —                  |
| Scarlet fever .....                                 | 2,441          | 2,295   | 54.1               | 51.1               |
| Puerperal fever .....                               | 18             | 21      | 2.4 <sup>2)</sup>  | 2.8 <sup>2)</sup>  |
| Pemphigus neonatorum <sup>1)</sup> .....            | 174            | 196     | 23.3 <sup>2)</sup> | 25.6 <sup>2)</sup> |
| Tetanus neonatorum <sup>1)</sup> .....              | 12             | 8       | 1.6 <sup>2)</sup>  | 1.0 <sup>2)</sup>  |
| Measles .....                                       | 24,661         | 57,371  | 546.2              | 1,278.4            |
| German measles .....                                | 6,201          | 10,668  | 137.4              | 237.7              |
| Chicken-pox .....                                   | 18,142         | 21,600  | 401.8              | 481.3              |
| Whooping-cough .....                                | 13,888         | 66,588  | 307.6              | 1,483.8            |
| Mumps .....   | 9,673          | 24,456  | 214.3              | 544.9              |
| Influenza .....                                     | 167,144        | 544,613 | 3,702.0            | 12,135.4           |
| Angina and tonsillitis .....                        | 207,485        | 178,444 | 4,595.4            | 3,976.2            |
| Tracheobronchitis .....                             | 122,303        | 109,839 | 2,708.8            | 2,447.5            |
| Bronchopneumonia .....                              | 49,657         | 47,086  | 1,099.8            | 1,049.2            |
| Lobar pneumonia .....                               | 4,909          | 4,744   | 108.7              | 105.7              |
| Cholera and enteritis .....                         | 65,761         | 49,961  | 1,456.5            | 1,113.3            |
| Epidemic hepatitis .....                            | 2,539          | 3,356   | 56.2               | 74.8               |
| Rheumatic fever .....                               | 856            | 983     | 18.9               | 21.9               |
| Erysipelas .....                                    | 2,645          | 2,825   | 58.6               | 62.9               |
| Gonorrhoea, not previously diagnosed .....          | 7,314          | 7,447   | 162.0              | 165.9              |
| Soft chancre, not previously diagnosed .....        | 10             | 9       | 0.2                | 0.2                |
| Acquired syphilis, not previously diagnosed .....   | 55             | 48      | 1.2                | 1.1                |
| Congenital syphilis, not previously diagnosed ..... | 4              | 6       | 0.1                | 0.1                |
| Lymphogranuloma inguinale .....                     | 15             | 7       | 0.3                | 0.2                |
| Delirium tremens .....                              | 41             | 56      | 0.9                | 1.2                |
| Scabies .....                                       | 2,011          | 2,453   | 44.5               | 54.7               |

<sup>1)</sup> Under one month. <sup>2)</sup> per 10,000 parturients. <sup>3)</sup> per 10,000 live-born.

28 aparaalytic cases, as against 26, 10 and 16 respectively in 1957. During the last 4 years only one death from poliomyelitis has been reported.

Since 1954 a slightly decreasing tendency has been observed in the number of reported cases of gonorrhoea, 7,314 cases being notified in 1958. Of these more than one half occurred in Copenhagen. In 1958 55 cases of acquired syphilis were

notified, hereof 31 in Copenhagen. The total number of cases of this disease was in 1957 48.

The distribution of notified cases by age, shown in Table 3, indicates that the epidemic morbidity has been decreasing from 1957 to 1958 in all age groups, and heaviest for the age groups 5—14 and 15—64 years.

As shown in Table 1 the crude mortality rate

Table 3.  
Notifiable diseases according to age 1958 and 1957.

| Age                           | Reported cases 1958 | per 1,000 population |      |
|-------------------------------|---------------------|----------------------|------|
|                               |                     | 1958                 | 1957 |
| 0—1 year .....                | 39,362              | 524                  | 618  |
| 1—4 years .....               | 149,481             | 505                  | 738  |
| 5—14 » .....                  | 178,760             | 228                  | 384  |
| 15—64 » males .....           | 143,235             | 101                  | 173  |
| 15—64 » females .....         | 140,913             | 97                   | 166  |
| 65 years and over, males ..   | 23,504              | 109                  | 148  |
| 65 years and over, females .. | 23,607              | 95                   | 134  |
| Total ....                    | 698,862             | 155                  | 251  |

Table 4.  
Deaths per 1,000 population by age and sex. 1958 and 1921.

|                        | 1958 |      | 1921 |      |
|------------------------|------|------|------|------|
|                        | M    | F    | M    | F    |
| Under 1 year .....     | 25.6 | 18.8 | 87.9 | 67.2 |
| 1—4 years .....        | 0.9  | 0.7  | 5.6  | 4.4  |
| 5—14 » .....           | 0.5  | 0.2  | 1.7  | 1.7  |
| 15—24 » .....          | 0.9  | 0.4  | 2.9  | 2.7  |
| 25—34 » .....          | 1.2  | 0.8  | 3.5  | 3.7  |
| 35—44 » .....          | 2.2  | 1.7  | 4.4  | 5.4  |
| 45—54 » .....          | 5.8  | 4.3  | 8.7  | 8.6  |
| 55—64 » .....          | 15.5 | 10.2 | 18.2 | 17.1 |
| 65 years and over .... | 66.1 | 56.7 | 70.4 | 70.8 |
| Total ....             | 9.8  | 8.6  | 11.2 | 11.2 |

Table 5.  
Causes of Death in Denmark 1958 and 1957. Abbreviated List (B).

|   |  | 1958   |        |        | 1957   |       |       | per 100,000 pop.<br>1958 |       |  | 1957 |
|---|--|--------|--------|--------|--------|-------|-------|--------------------------|-------|--|------|
|   |  | M      | F      | Total  | Total  | M     | F     | Total                    | Total |  |      |
| B 1   | Tuberculosis of respiratory system .....   | 122    | 71     | 193    | 170    | 5.5   | 3.1   | 4.3                      | 3.8   |  |      |
| B 2   | Tuberculosis, other forms .....  | 6      | 8      | 14     | 29     | 0.3   | 0.4   | 0.3                      | 0.6   |  |      |
| B 3   | Syphilis and its sequelae .....  | 27     | 16     | 43     | 77     | 1.2   | 0.7   | 1.0                      | 1.7   |  |      |
| B 4   | Typhoid fever .....  | —      | —      | —      | 1      | —     | —     | —                        | 0.0   |  |      |
| B 6   | Dysentery, all forms .....   | 1      | —      | 1      | 1      | 0.0   | —     | 0.0                      | 0.0   |  |      |
| B 7   | Scarlet fever and streptococcal sore throat ..   | —      | —      | —      | 2      | —     | —     | —                        | 0.0   |  |      |
| B 8   | Diphtheria .....   | —      | —      | —      | —      | —     | —     | —                        | —     |  |      |
| B 9   | Whooping cough .....   | 1      | 2      | 3      | 25     | 0.0   | 0.1   | 0.1                      | 0.6   |  |      |
| B 10  | Meningococcal infections .....   | 2      | —      | 2      | 7      | 0.1   | —     | 0.0                      | 0.2   |  |      |
| B 12  | Acute poliomyelitis .....  | 1      | —      | 1      | —      | 0.0   | —     | 0.0                      | —     |  |      |
| B 14  | Measles .....  | 1      | 1      | 2      | 12     | 0.0   | 0.0   | 0.0                      | 0.3   |  |      |
| B 17  | All other diseases classified as infectious and<br>parasitic .....                       | 65     | 55     | 120    | 125    | 2.9   | 2.4   | 2.7                      | 2.8   |  |      |
| B 18  | Malign. neoplasms, incl. neoplasms of lymph.<br>and haematopoietic tissues .....         | 4,514  | 4,586  | 9,100  | 9,009  | 201.7 | 201.4 | 201.6                    | 200.7 |  |      |
| B 19  | Benign and unspecified neoplasms .....   | 167    | 181    | 348    | 339    | 7.5   | 8.0   | 7.7                      | 7.6   |  |      |
| B 20  | Diabetes mellitus .....  | 119    | 141    | 260    | 309    | 5.3   | 6.2   | 5.8                      | 6.9   |  |      |
| B 21  | Anæmias .....  | 43     | 38     | 81     | 95     | 1.9   | 1.7   | 1.8                      | 2.1   |  |      |
| B 22  | Vasc. lesions affect. central nervous system ..  | 2,527  | 2,848  | 5,375  | 5,306  | 112.9 | 125.1 | 119.0                    | 118.2 |  |      |
| B 23  | Nonmeningococcal meningitis .....  | 24     | 16     | 40     | 51     | 1.1   | 0.7   | 0.9                      | 1.1   |  |      |
| B 24  | Rheumatic fever .....  | 6      | 6      | 12     | 14     | 0.3   | 0.3   | 0.3                      | 0.3   |  |      |
| B 25  | Chronic rheumatic heart disease .....  | 96     | 193    | 289    | 340    | 4.3   | 8.5   | 6.4                      | 7.6   |  |      |
| B 26  | Arteriosclerotic and degenerative heart dis-<br>ease .....                               | 6,030  | 4,400  | 10,430 | 10,188 | 269.4 | 193.3 | 231.0                    | 227.0 |  |      |
| B 27  | Other diseases of heart .....  | 1,163  | 1,016  | 2,179  | 2,085  | 52.0  | 44.6  | 48.3                     | 46.5  |  |      |
| B 28  | Hypertension with heart disease .....  | 269    | 474    | 743    | 741    | 12.0  | 20.8  | 16.5                     | 16.5  |  |      |
| B 29  | Hypertension without mention of heart .....  | 54     | 62     | 116    | 137    | 2.4   | 2.7   | 2.6                      | 3.1   |  |      |
| B 30  | Influenza .....  | 61     | 58     | 119    | 435    | 2.7   | 2.6   | 2.6                      | 9.7   |  |      |
| B 31  | Pneumonia .....  | 435    | 396    | 831    | 855    | 19.4  | 17.4  | 18.4                     | 19.1  |  |      |
| B 32  | Bronchitis .....   | 126    | 99     | 225    | 280    | 5.6   | 4.4   | 5.0                      | 6.2   |  |      |
| B 33  | Ulcer of stomach and duodenum .....  | 181    | 82     | 263    | 278    | 8.1   | 3.6   | 5.8                      | 6.2   |  |      |
| B 34  | Appendicitis .....   | 58     | 36     | 94     | 88     | 2.6   | 1.6   | 1.9                      | 2.0   |  |      |
| B 35  | Intestinal obstruction and hernia .....  | 153    | 141    | 294    | 288    | 6.8   | 6.2   | 6.5                      | 6.4   |  |      |
| B 36  | Gastritis, duodenitis, enteritis and colitis, ex-<br>cept diarrhoea of the newborn ..... | 75     | 76     | 151    | 154    | 3.4   | 3.3   | 3.3                      | 3.4   |  |      |
| B 37  | Cirrhosis of liver .....   | 135    | 203    | 338    | 380    | 6.0   | 8.9   | 7.5                      | 8.5   |  |      |
| B 38  | Nephritis and nephrosis .....  | 127    | 132    | 259    | 224    | 5.7   | 5.8   | 5.7                      | 5.0   |  |      |
| B 39  | Hyperplasia of prostate .....  | 574    | .      | 574    | 540    | 25.6  | .     | 12.7                     | 12.0  |  |      |
| B 40  | Complications of pregnancy, childbirth and<br>the puerperium .....                       | .      | 33     | 33     | 31     | .     | 1.4   | 0.7                      | 0.7   |  |      |
| B 41  | Congenital malformations .....   | 257    | 190    | 447    | 412    | 11.5  | 8.4   | 9.9                      | 9.2   |  |      |
| B 42  | Birth injuries, postnatal asphyxia and atelec-<br>tasis .....                            | 318    | 182    | 500    | 518    | 14.2  | 8.0   | 11.1                     | 11.5  |  |      |
| B 43  | Infections of the newborn .....  | 22     | 24     | 46     | 36     | 1.0   | 1.1   | 1.0                      | 0.8   |  |      |
| B 44  | Other diseases peculiar to early infancy, and<br>immaturity unqualified .....            | 275    | 199    | 474    | 486    | 12.3  | 8.7   | 10.5                     | 10.8  |  |      |
| B 45  | Senility without mention of psychosis, ill-<br>defined and unknown causes .....          | 266    | 249    | 515    | 527    | 11.9  | 10.9  | 11.4                     | 11.7  |  |      |
| B 46  | All other diseases .....   | 1,850  | 2,234  | 4,084  | 4,125  | 82.6  | 98.1  | 90.5                     | 91.9  |  |      |
| BN 47   | Fractures, head injuries and internal injuries   | 942    | 690    | 1,632  | 1,592  | 42.1  | 30.3  | 36.2                     | 35.5  |  |      |
| BN 48   | Burns .....  | 16     | 17     | 33     | 50     | 0.7   | 0.7   | 0.7                      | 1.1   |  |      |
| BN 49   | Effects of poisons .....   | 397    | 284    | 681    | 702    | 17.7  | 12.5  | 15.1                     | 15.7  |  |      |
| BN 50   | All other injuries .....   | 485    | 130    | 615    | 666    | 21.7  | 5.7   | 13.6                     | 14.8  |  |      |
| Total   | .....  | 21,991 | 19,569 | 41,560 | 41,730 | 982.4 | 859.6 | 920.4                    | 929.8 |  |      |
| Alternative classification of deaths from accidents, poisoning, and violence<br>(BN 47 — BN 50) according to external cause:: |  |        |        |        |        |       |       |                          |       |  |      |
| BE 47   | Motor vehicle accidents .....  | 524    | 134    | 658    | 649    | 23.4  | 5.9   | 14.6                     | 14.5  |  |      |
| BE 48   | All other accidents .....  | 652    | 667    | 1,319  | 1,346  | 29.1  | 29.3  | 29.2                     | 30.0  |  |      |
| BE 49   | Suicide and self-inflicted injury .....  | 652    | 305    | 957    | 991    | 29.1  | 13.4  | 21.2                     | 22.1  |  |      |
| BE 50   | Homicide and operations of war .....   | 12     | 15     | 27     | 24     | 0.5   | 0.7   | 0.6                      | 0.5   |  |      |

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Table 6.  
Mortality from suicide 1951—58.

| Actual numbers |      |     |       | per 100,000 population |      |                   |                |                |                      |                   |                |                |                      |      |  |
|----------------|------|-----|-------|------------------------|------|-------------------|----------------|----------------|----------------------|-------------------|----------------|----------------|----------------------|------|--|
| Total          | M.   | F.  | Total | M.                     | F.   | Males             |                |                |                      | Females           |                |                |                      |      |  |
|                |      |     |       |                        |      | under<br>25 years | 25—44<br>years | 45—64<br>years | 65 years<br>and over | under<br>25 years | 25—44<br>years | 45—64<br>years | 65 years<br>and over |      |  |
|                |      |     |       |                        |      |                   |                |                |                      |                   |                |                |                      |      |  |
| 1951 .....     | 1014 | 686 | 328   | 23.6                   | 32.1 | 15.1              | 5.4            | 40.7           | 63.8                 | 52.5              | 3.0            | 20.1           | 28.1                 | 19.1 |  |
| 1952 .....     | 993  | 676 | 317   | 22.9                   | 31.4 | 14.5              | 5.7            | 37.5           | 60.2                 | 61.3              | 2.7            | 16.8           | 29.5                 | 20.1 |  |
| 1953 .....     | 1054 | 701 | 353   | 24.1                   | 32.3 | 16.0              | 6.4            | 37.2           | 64.4                 | 58.5              | 2.9            | 19.2           | 29.6                 | 27.5 |  |
| 1954 .....     | 1028 | 687 | 341   | 23.3                   | 31.4 | 15.4              | 5.3            | 35.2           | 64.0                 | 59.3              | 2.1            | 16.3           | 31.0                 | 28.6 |  |
| 1955 .....     | 1036 | 705 | 331   | 23.3                   | 32.0 | 14.8              | 4.9            | 37.5           | 63.1                 | 57.1              | 2.4            | 16.4           | 28.0                 | 27.9 |  |
| 1956 .....     | 1004 | 668 | 336   | 22.5                   | 30.2 | 14.9              | 5.9            | 33.0           | 61.0                 | 54.4              | 1.9            | 18.3           | 27.3                 | 26.7 |  |
| 1957 .....     | 991  | 660 | 331   | 22.1                   | 29.7 | 14.6              | 4.5            | 33.8           | 56.0                 | 64.2              | 2.3            | 17.8           | 25.4                 | 29.0 |  |
| 1958 .....     | 957  | 652 | 305   | 21.2                   | 29.1 | 13.4              | 4.3            | 32.1           | 59.3                 | 55.8              | 2.8            | 14.5           | 24.2                 | 25.1 |  |

was practically unchanged from 1957 to 1958, 9.3 and 9.2 per 1,000 respectively. It will be seen from Table 4 that the decrease in mortality rate since 1921 has been heavier for females than for males, and more pronounced in the younger age groups.

The infant mortality rate is continuously decreasing, the rate being 25.2, 24.9, 23.4 and 22.4 per 1,000 liveborn respectively in 1955, 1956, 1957 and 1958.

From Table 5 will be seen that the tuberculosis mortality has, for the first time during many years, increased slightly. The mortality from re-respiratory tuberculosis was in 1958 4.3 per 100,000 population as against 3.8 in 1957. The mortality from extrapulmonary tuberculosis decreased, however, from 0.6 to 0.3 per 100,000, resulting in a mortality rate for all forms of tuberculosis of 4.6 against 4.4 in 1957. Malignant neoplasms and arteriosclerotic and degenerative heart diseases are the two leading causes of death and make up 47 per cent of all deaths. Deaths caused by accidents amounts to 4.8 per cent of all deaths. It should be borne in mind, however, that this group includes deaths caused by fall and stumbling, even if the death did not occur until some time after the accident, as is often the case in the older age groups. As could be expected after the influenza epidemic in 1957, the number of deaths from this disease decreased considerably in 1958, as did deaths from infectious diseases. Altogether the total number of deaths decreased slightly.

The number of suicides decreased from 991 in 1957 to 957 in 1958, and the mortality rate is now

21.2 per 100,000 population, the lowest rate recorded since 1943. The rate for males was, however, at the 1957-level as late as in 1946, whereas the female suicide rate has been higher ever since 1942. The number of suicides and the age specific rates for males and females since 1951 are shown in Table 6, from which it appears that there has been a slightly downward trend since 1953<sup>1</sup>).

The rate of notified cases of respiratory tuberculosis was the same in 1958 as in 1957, namely 25 per 100,000 population, the actual number of cases being 1105 as against 1127 in 1957. The number of known cases of respiratory tuberculosis was at the end of 1957 10,834 or 241 per 100,000 population. There were 2805 known cases, or 378 per 100,000 in Copenhagen. The age distribution of known cases at the end of the year is shown in Table 7. 79.7 per cent of all notified cases were bacillary as against 80.6 per cent in 1956. 198 cases of extrapulmonary tuberculosis or 4.4 per 100,000 were notified in 1957, against 161 or 3.1 per 100,000 in 1956. There were 103 chest clinics in Denmark in 1957. 959,202 persons were examined, 1,419,821 consultations and 47,772 BCG-vaccinations were given.

According to law, pregnant women can have 10 examinations free of charge, 3 by physician and 7 by midwife. In 1957/58 the number of visits of physicians and midwives were 183,305 and 307,274 respectively. Table 8 shows the utilization rate during later years in rural and urban areas. The rate seems much higher in towns than in rural areas, and sometimes exceeds 100 per cent. The reason for this is that a number of women living in rural areas visit physicians in the towns, and therefore are registered under urban areas.

The number of Public Health Nurses for infants was 362 at the end of 1958 against 358 in 1957. 47,376 infants, or 62.9 per cent of all live-born, were supervised at the end of the year, as against 62.2 per cent in 1956. Only 461, or 0.9 per

Table 7.  
Respiratory tuberculosis by age and sex 1957.

|                        | Notified cases |     | Known cases<br>Dec. 31st 1957 |      |
|------------------------|----------------|-----|-------------------------------|------|
|                        | M              | F   | M                             | F    |
| 0—4 years .....        | 45             | 32  | 126                           | 113  |
| 5—14 » .....           | 31             | 31  | 275                           | 257  |
| 15—24 » .....          | 65             | 68  | 371                           | 592  |
| 25—44 » .....          | 194            | 199 | 2354                          | 2880 |
| 45—64 » .....          | 133            | 85  | 1829                          | 1091 |
| 65 years and over .... | 107            | 65  | 549                           | 397  |
| Total .....            | 625            | 480 | 5504                          | 5330 |

<sup>1</sup>) See: Karen Dreyer, Comparative Suicide Statistics. Danish Medical Bulletin, 1959, 6: 65.

Table 8.  
Number of visits to physicians and midwives according to Act concerning Pregnancy Hygiene.

|  | 1937/58                            | 1951/56<br>average                 | 1946/51<br>average                | 1946/47                           |
|--|------------------------------------|------------------------------------|-----------------------------------|-----------------------------------|
| 1st visit to physician .....   | 73,066                             | 71,482                             | 69,622                            | 71,990                            |
| Utilization (i.e. 1st visit in per cent of live-born children) .....               | 102 <sup>1)</sup> 94 <sup>2)</sup> | 103 <sup>1)</sup> 85 <sup>2)</sup> | 90 <sup>1)</sup> 72 <sup>2)</sup> | 83 <sup>1)</sup> 65 <sup>2)</sup> |
| 2nd and 3rd visit to physician .....   | 110,239                            | 102,309                            | 95,033                            | 90,019                            |
| Utilization (i.e. 2nd and 3rd visit in per cent of 1st visit) .....                | 77 <sup>1)</sup> 75 <sup>2)</sup>  | 72 <sup>1)</sup> 71 <sup>2)</sup>  | 72 <sup>1)</sup> 64 <sup>2)</sup> | 71 <sup>1)</sup> 54 <sup>2)</sup> |
| Visits to midwives (maximum 7) .....   | 307,274                            | 287,321                            | 266,581                           | 260,533                           |
| Utilization (i.e. visits to midwives in per cent of 1st visit to physicians) ..... | 67 <sup>1)</sup> 55 <sup>2)</sup>  | 64 <sup>1)</sup> 52 <sup>2)</sup>  | 63 <sup>1)</sup> 47 <sup>2)</sup> | 62 <sup>1)</sup> 41 <sup>2)</sup> |
| Number of live-born children in calendar year .....                                | 75,300                             | 77,000                             | 87,140                            | 96,100                            |

<sup>1)</sup> Towns. <sup>2)</sup> Rural districts.

cent of the homes refused to receive the Public Health Nurse. 810,169 visits were paid.

195 of the aforementioned Public Health Nurses were also working as School Nurses, and 66 nurses worked exclusively as such. The corresponding figures for 1956 were 189 and 60 respectively.

At the end of the school-year 1957/58 dental services were given to school children in the Capital, in 44 towns and in 51 rural municipalities. 353 dentists were working in this field, hereof 107 in the Capital, 150 in other towns and 96 in rural areas. In a few municipalities dental services were rendered by practising dentists in their office.

A survey of the number of beds in hospitals and other institutions for care of the sick is given in Table 9. There were 26,160 beds in 144

hospitals, and 19,437 in other institutions. The total number of beds amounts to 10.16 per 1,000 population.

Table 10 gives information about cases treated in the hospitals in 1955, 1956 and 1957.

The number has been increasing, and was 119 per 1,000 population in 1957 as against 115 and 113 in 1956 and 1955 respectively. The number of cases 532,592 exceeds the number of patients, because in some cases more than one diagnosis is given. A change in the relative frequency of the diagnosis-groups has taken place during later years. Some groups are now more frequent than before, e. g. diseases of the circulatory system, diseases of pregnancy and childbirth, neoplasms and traumatic injuries. There are on the other hand relatively fewer cases of skin diseases and

Table 9.  
Beds in hospitals and other institutions for treatment of the sick. December 31st 1957.

|   | No. of<br>institutions | No. of<br>departments | No. of beds<br>total | per 1,000<br>population |
|---|------------------------|-----------------------|----------------------|-------------------------|
| 1. Hospitals:                           |                        |                       |                      |                         |
| Hospitals with special departments .... | 72                     | 254                   | 20,412               | 4.55                    |
| Hospitals mostly with mixed departments | 72                     | 75                    | 5,748                | 1.28                    |
| All hospitals .....                     | 144                    | 329                   | 26,160               | 5.83                    |
| 2. Other institutions:                  |                        |                       |                      |                         |
| Infirmaries in old-age homes etc. ....  | 60                     | —                     | 3,440                | 0.77                    |
| Private clinics .....                   | 14                     | —                     | 269                  | 0.06                    |
| Municipal maternity hospitals .....     | 3                      | —                     | 104                  | 0.02                    |
| Nursing institutions .....              | 44                     | —                     | 2,729                | 0.61                    |
| Tuberculosis hospitals .....            | 32                     | —                     | 2,402                | 0.54                    |
| Mental hospitals .....                  | 10                     | —                     | 9,511 <sup>1)</sup>  | 2.12                    |
| Hospitals for epileptics .....          | 3                      | —                     | 982                  | 0.22                    |
| Total .....                             | 166                    | —                     | 19,437               | 4.34                    |
| All hospitals and institutions .....    | 310                    | —                     | 45,597               | 10.16                   |
| In addition accommodation in:           |                        |                       |                      |                         |
| Asylums for feeble-minded .....         |                        |                       | 7,511 <sup>2)</sup>  | 1.67                    |
| Institutions for the blind .....        |                        |                       | 363                  | 0.08                    |
| Institutions for deaf-mutes .....       |                        |                       | 633                  | 0.14                    |

See table 11 concerning activity of special departments.

<sup>1)</sup> In addition accommodation for 911 patients in family care.

<sup>2)</sup> In addition accommodation for 7,376 patients in family care.

Table 10.  
Survey of Cases admitted to Danish General Hospitals, 1957, 1956 and 1955.

|   | Main diagnoses |         |         | per 1,000 diagnoses |         |         |
|---|----------------|---------|---------|---------------------|---------|---------|
|   | 1957           | 1956    | 1955    | 1957                | 1956    | 1955    |
| 1 Respiratory diseases .....                            | 25,263         | 21,795  | 19,810  | 47.4                | 42.5    | 39.6    |
| 2 Senile diseases .....                                 | 634            | 611     | 733     | 1.2                 | 1.2     | 1.5     |
| 3 Diseases of musculo-skeletal system .....             | 24,175         | 23,287  | 23,726  | 45.4                | 45.4    | 47.4    |
| 4 Diseases of the blood and blood-forming organs..      | 4,083          | 3,855   | 3,649   | 7.7                 | 7.5     | 7.3     |
| 5 Endocrine diseases .....                              | 17,748         | 16,289  | 15,623  | 33.3                | 31.8    | 31.2    |
| 6 Diseases of the digestive system .....                | 79,466         | 77,694  | 80,316  | 149.2               | 151.6   | 160.4   |
| 7a Poisonings, acute .....                              | 4,944          | 5,153   | 5,291   | 9.3                 | 10.0    | 10.6    |
| 7b Poisonings, chronic .....                            | 1,413          | 1,350   | 1,366   | 2.7                 | 2.6     | 2.7     |
| 8 Skin diseases .....                                   | 14,544         | 13,492  | 13,180  | 27.3                | 26.3    | 26.3    |
| 9 Infectious diseases*) .....                           | 18,660         | 17,617  | 18,192  | 35.0                | 34.4    | 36.3    |
| 10 Diseases of the circulatory system .....             | 37,039         | 34,343  | 33,362  | 69.5                | 67.0    | 66.6    |
| 11a Diseases of the genitals, male (excl. venerea) ..   | 7,995          | 7,204   | 6,829   | 15.0                | 14.1    | 13.6    |
| 11b Diseases of the genitals, female (excl. venerea) .. | 36,596         | 36,661  | 35,076  | 68.7                | 71.5    | 70.0    |
| 12 Malformations, congenital .....                      | 3,733          | 3,700   | 3,318   | 7.0                 | 7.2     | 6.6     |
| 13 Organic diseases of the nervous system .....         | 17,431         | 16,858  | 15,896  | 32.7                | 32.9    | 31.7    |
| 14 Functional diseases of the nervous system .....      | 22,621         | 22,758  | 22,461  | 42.5                | 44.4    | 44.8    |
| 15 Infantile diseases .....                             | 3,126          | 3,158   | 2,979   | 5.9                 | 6.2     | 5.9     |
| 16 Diseases of the urinary system .....                 | 14,746         | 13,884  | 13,204  | 27.7                | 27.1    | 26.4    |
| 17 Diseases of pregnancy and childbirth .....           | 31,958         | 31,516  | 29,733  | 60.0                | 61.5    | 59.4    |
| 18 Normal pregnancy and birth .....                     | 47,160         | 44,924  | 44,867  | 88.6                | 87.6    | 89.6    |
| 19a Tumours, maglinant .....                            | 20,913         | 19,937  | 19,252  | 39.3                | 38.9    | 38.4    |
| 19b Tumours, benignant .....                            | 13,978         | 13,652  | 12,715  | 26.2                | 26.6    | 25.4    |
| 20 Traumatic injuries .....                             | 53,549         | 53,142  | 49,973  | 100.5               | 103.7   | 99.8    |
| 21 Eye diseases .....                                   | 6,967          | 7,040   | 6,210   | 13.1                | 13.7    | 12.4    |
| 22 Ear diseases .....                                   | 7,542          | 7,181   | 7,566   | 14.2                | 14.0    | 15.1    |
| 23 Observations and other uncertain cases .....         | 16,308         | 15,525  | 15,517  | 30.6                | 30.3    | 31.0    |
| Total .....   | 532,592        | 512,626 | 500,844 | 1000.0              | 1,000.0 | 1,000.0 |
| per 1,000 population .....                              | 119            | 115     | 113     | —                   | —       | —       |
| *) hereof venereal diseases .....                       | 819            | 793     | 861     | 1.5                 | 1.5     | 1.7     |

Table 11.  
Number of beds, admissions and average length of stay  
in special departments in Danish hospitals 1956/57.

| Departments             | No. of<br>depart-<br>ments | No. of<br>beds | Admis-<br>sions | Average length<br>of stay in days |      |
|-------------------------|----------------------------|----------------|-----------------|-----------------------------------|------|
|                         |                            |                |                 | 1957                              | 1956 |
| Medical .....           | 59                         | 6448           | 104,619         | 20                                | 21   |
| Surgical .....          | 57                         | 6466           | 156,355         | 15                                | 15   |
| Neurological .....      | 6                          | 489            | 8,611           | 21                                | 21   |
| Brain-surgical .....    | 4                          | 190            | 4,525           | 16                                | 17   |
| Chest-surgical .....    | 2                          | 119            | 1,446           | 25                                | 25   |
| Orthopaedic .....       | 6                          | 472            | 8,439           | 21                                | 21   |
| Gynaecological .....    | 15                         | 1061           | 32,441          | 12                                | 12   |
| Maternal .....          | 6                          | 394            | 11,858          | 10                                | 11   |
| Otolaryngological ..... | 27                         | 763            | 21,262          | 11                                | 11   |
| Ophthalmological .....  | 21                         | 336            | 6,040           | 15                                | 15   |
| Paediatric .....        | 13                         | 907            | 12,544          | 23                                | 25   |
| Dermato-venereal .....  | 7                          | 481            | 5,681           | 26                                | 28   |
| Radium .....            | 3                          | 302            | 4,254           | 25                                | 25   |
| X-ray .....             | 1                          | 27             | 213             | 38                                | 37   |
| Physiurgie .....        | 3                          | 74             | 862             | 31                                | 32   |
| Epidemic .....          | 4                          | 568            | 8,698           | 18                                | 19   |
| Psychiatric .....       | 6                          | 609            | 11,773          | 20                                | 22   |
| Tuberculosis .....      | 17                         | 767            | 3,203           | 62                                | 62   |
| Total 1957 .....        | 257                        | 20473          | 402,814         | —                                 | —    |
| Total 1956 .....        | 250                        | 20211          | 387,966         | —                                 | —    |

Table 12.

Working expenses of all public hospitals 1956/57.  
In Danish crowns (1 D.cr. — 1 sh. — 0,14 U.S.\$).

|   | Total<br>in<br>mill.<br>D. cr. | In per cent of total: |       |                   |
|---|--------------------------------|-----------------------|-------|-------------------|
|   |                                | Wages                 | Board | Other<br>expenses |
| County and municipal<br>hospitals ..... | 345.3                          | 60.4                  | 8.8   | 30.8              |
| State hospitals .....                   | 43.1                           | 66.2                  | 5.7   | 28.1              |
| Total 1956/57 .....                     | 388.4                          | 61.0                  | 8.4   | 30.6              |
| Total 1955/56 .....                     | 353.4                          | 59.8                  | 9.4   | 30.8              |

infectious diseases, including V.D. The total number in these two groups has decreased from 75,400 in 1945 (17.5 per cent) to 33,200 in 1957 (6.2 per cent), a decrease which alone has enabled the hospitals to treat about 42,000 additional patients with other diseases.

A total of 511,765 patients were treated in the hospitals in 1957. The number of patient-days was 8.7 million, and the average length of stay 17 days.

The activity of the special hospital departments is shown in Table 11. These departments with a total of 20,473 beds, treated 402,814 patients. The length of stay per patient was roughly the same in 1956 and 1957, viz, for surgical departments 15 days in both years, and for medical departments 21 and 20 days respectively.

The working expenses of the public hospitals in 1956/57 were 388.4 million Danish crowns, against 353.4 million in 1955/56 (see Table 12). The largest entry was wages with 61 percent of the total.

The average expense per bed-day in 1956/57 was 49.22 Danish crowns, against 44.92 Danish crowns in 1955/56, and the expense per board-day was 2.71 Danish crowns against 2.75 in the previous year. The total expense per capita was 86.54 Danish crowns in 1956/57 and 79.12 in 1955/56.

The total number of physicans employed in the public hospitals in 1957 was 1,821, hereof 1,571 in city- and county hospitals. 7,299 registered nurses were working in the public hospitals, of whom 6,342 were in city- and county hospitals. The number of student nurses was 4,137 in public hospitals, hereof 3,957 in city- and county hospitals. In all hospitals, public as well as private, there were 2,080 physicians, 8,290 registered nurses and 4,404 student nurses. A total of 2,356 physicians were employed by all curative institutions; of these 603 were chief physicians.

## THE HYDROGEN ION CONCENTRATION IN ARTERIAL BLOOD

A CLINICAL STUDY OF PATIENTS  
WITH DIABETES MELLITUS AND DISEASES OF  
THE KIDNEYS, LUNGS AND HEART

Summary of thesis

By BENT MØLLER

The object of the work has been to evaluate the significance of the various laboratory methods available to-day for estimating the acid-base status of the organism, by means of determinations of the hydrogen ion concentration and carbon dioxide content in arterial plasma from which analyses  $pCO_2$  and standard bicarbonate may be calculated. The results are plotted in Peters' chart from 1923. The arterial oxygen saturation as well as haemoglobin level and serum electrolytes have also been determined.

Practically all previous publications on disturbances of the neutrality regulation are based on the assumption that acids are defined as anions and bases as cations. Consequently the anion-cation equilibrium has been adopted as an expression of the nature and degree of an acid-base abnormality. A much better understanding of these problems can be obtained by employing Brønsted's definitions in the clinico-physiological description.

Metabolic acidosis due to diabetic ketosis or renal failure was in nearly all cases associated with a respiratory compensation, of which a clinical evaluation could give no more than a rough estimate. An exact knowledge of this compensation is necessary before instituting base therapy to very ill patients, as the treatment of metabolic acidosis with even less than one-half of the bicarbonate dose calculable on the basis of Van Slyke's nomogram from 1934 was often observed to give a too high pH. The risk of accumulation of sodium is pointed out. It is emphasized that neither the  $CO_2$  content nor the standard bicarbonate elucidates whether a respiratory compensation is present or not.

Pronounced respiratory disturbances owing to pulmonary insufficiency or congestive heart failure cannot be adequately characterized without arterial blood analyses for oxygen saturation, pH, and  $pCO_2$ . In acute changes of the pulmonary function — especially when treatment with oxygen, tracheobronchial toilet, or artificial respiration is considered — arterial blood analyses will in many cases contribute essentially towards clinical control of the patients.

### Reference:

Møller, Bent: Acta Med. Scand. 1959, 165: Suppl. 348.



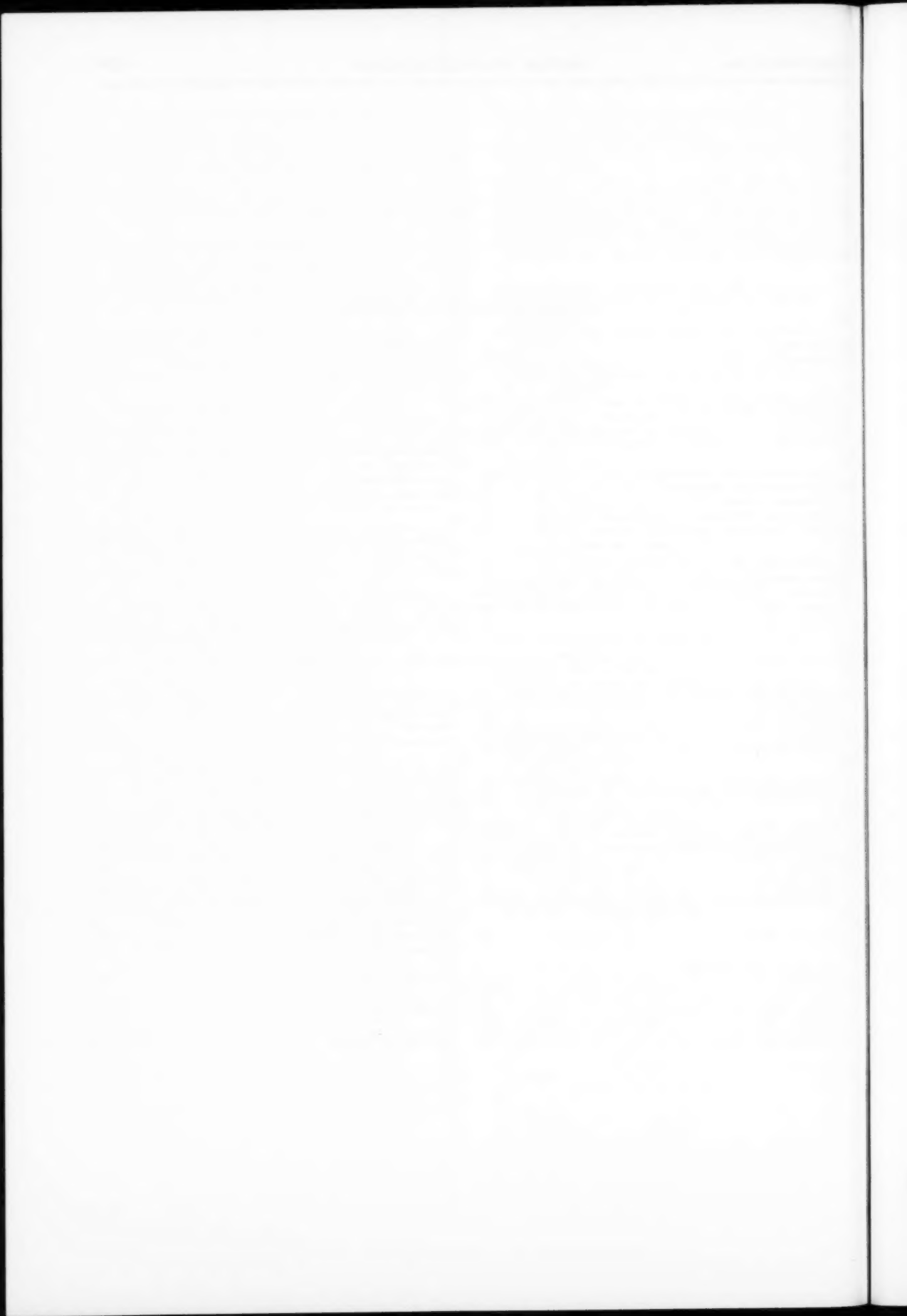
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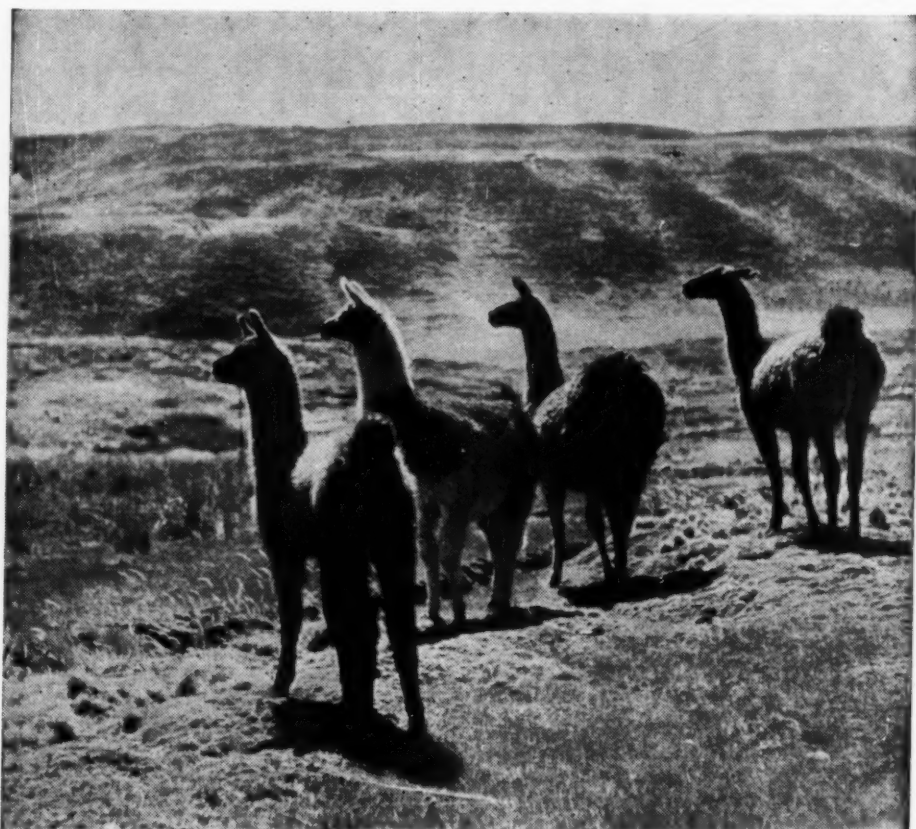
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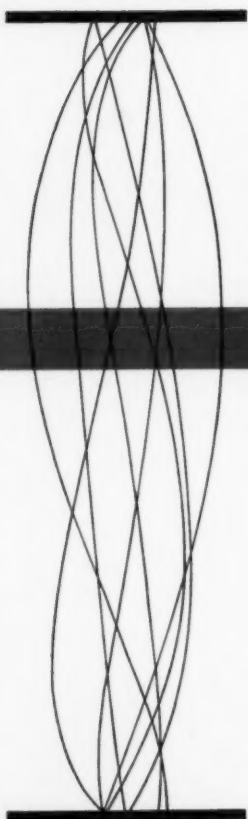
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